Yards and Terminals

AND

Their Operation

BY

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CHAPTER I

Relative Importance of Terminals

The relative importance of the freight terminals of a line of railroad is usually not understood, and the attention they deserve is not always given to them. Poor's Manual gives the mileage of steam railroads in the United States on December 31, 1903 as 207,335 and in 1904 as 212,349. The gross earnings in 1904 were $1,977,638,713; net earnings $641,807,-884 and the ratio of expenses to earnings, 67.56 per cent. During the year 1904 there were 543,532,369 freight-train miles made and 1,277,771,573 tons moved a total distance of 173,628,034,040 miles. The gross earnings from freight were $1,374,102,275.

Average receipts per ton mile	0.791	cents
Average receipts per ton moved	107.53	cents
Average receipts per freight-train mile	252.79	cents
Average receipts per mile of road	$9,249.00	
Average number of tons per mile of road	5,976.00	
Average number of tons per freight-train mile	319.44	tons
Average haul per ton, train miles	135.88	miles

In 1902 the total length of track in operation in the United States was about 289,000 miles, including in round numbers 17,000 miles of second, third and fourth tracks and 62,000 miles of yard tracks and side tracks. From this it will be seen that for every four miles of road (computing double track on the basis of actual distance covered) there is used one mile of switching or terminal track. Some years ago it was computed that the switching mileage of some of the larger roads ran as high as 37.3% of the entire number of revenue train miles, and the tendency is for this proportion to grow rather than to decrease with the general increase in business, the density of traffic, and the demands of the public generally

for quicker movement and delivery and for fast freight service on any commodity for which money is paid. It can be conservatively stated that 30 per cent. of all railroad mileage, or one-fifth of all the track, is set aside for terminal work and does not enter into the actual work of moving the freight from one point to another.

There are but two roads actually entering New York City to-day, although there are 16 making it a terminal. The 14 others find it necessary to use water transportation to deliver freight to the city. There are nevertheless 80 transportation companies — rail and water — having freight stations in New York City. Some of these companies have as many as six or seven different stations.

Handling freight traffic in and through New York is doubtless the most complicated terminal problem in the world, and from it many lessons may be learned. As the greatest port of entrance to this country, the increasing volume of traffic, with the growing demands for quicker movement, would in themselves present endless operating and traffic questions; but added to this is the constant tendency on the part of industries, warehouses, etc., to crowd the water's edge to an extent necessitating the confinement of railroad lines to present limits or compelling enormous expenditures to secure more territory. The gradual solving of the terminal problem of Greater New York may well be watched by operating officers and it is difficult to conceive of a terminal situation where some of the deductions cannot be advantageously applied.

Handling the freight traffic of New York involves an enormous water fleet to care for the lighterage and an extensive system of water front piers, docks, and float bridges for the transfer of freight between the rail and water lines, in addition to the large freight yards for classifying, delivering and forwarding freight cars. There are no available records of the exact number of boats engaged in the New York harbor lighterage business, but estimating, with the figures to be had, there are 1,000 steam vessels and 9,000 without steam, making 10,000 craft engaged in this work in the

harbor. Within the harbor limits there are about 50 dry docks and plants for marine construction and repairing, representing investments aggregating about $10,000,000. To show what has been done, and what may be expected in the way of future development, the following figures of the distance and available wharf room of the New York harbor water front are given:

	WATER FRONT		WHARF ROOM
Manhattan	44 miles		93 miles
Brooklyn	132		197
Queens	116		132
Richmond	51		69
Bronx	105		113
Total	448 miles	Total	604 miles
N. J. Shore — Amboy to Fort Lee	30		96
Total	478 miles	Total	700 miles

The Department of Docks and Ferries' receipts for 1902, from leases, wharfage, etc., were $3,016,326.52. In addition to thousands of tons of freight handled by lighters, there are about 1,000 cars handled on floats daily, between Canal street on the North river and Jackson street on the East river, without obstructing any street room. The usual charge for lighterage, as prorated, is 3 cents per 100 lbs., and the claim is made that in some instances the actual cost runs as high as 3¾ or 4 cents. Exclusive of grain and coal, three railroads alone pour into Jersey City daily about 30,000 tons of freight, to be transported to New York City.

About 100,000,000 people cross and recross the Hudson river every year, and about 1,080 passenger trains arrive at and depart daily from five stations in Jersey City, on 10 main tracks and load and unload their passengers on 48 station tracks. When the Brooklyn Bridge was opened in 1883, the East river ferries carried about 43,000,000 passengers annually. In 1904 the bridge alone carried over 100,000,000 paying passengers, and about 10,000,000, non-paying pedestrians, and the ferries over 100,000,000, an increase of about 500 per cent. in 17 years, largely due to improved facilities. The increase in population in the Boroughs of Brooklyn and Queens has been about 60 per cent. in the same period.

To illustrate further the educational effect on travel, and the increased travel brought about by providing improved transportation facilities, it may not be amiss to note the growth of Greater New York's urban passenger traffic. In 1880 the surface lines carried 226,669,173, the elevated lines 60,831,757 — a total of 287,500,930 passengers. In 1890, surface 331,413,336, elevated 271,711,014 — total 603,124,-350. In 1900, surface 816,661,361, elevated 251,128,913 — total 1,067,740,274. In 1902, surface 866,692,081, elevated 284,864,901 — total 1,151,556,982. These statistics of passenger traffic in a great and complicated terminal may not seem germane, but they show that improved facilities increase business far beyond the proportionate increase of population. In a like manner, improved terminals resulting in prompter and cheaper handling of freight tend to a more general utilization of freight lines. In the United States the number of tons moved one mile was in 1890, 65 billions; 1897, 93 billions; 1904, 173 billions. It is only during a comparatively recent period that the southern states have generally supplied the northern and northwestern markets with early fruits and vegetables. It has become a regular part of the business of some of the north and south railroads to haul watermelons, and other fruits and vegetables north during certain seasons, and a few weeks later haul them in the opposite direction. Florida, Georgia and other southern States may ship melons, strawberries, etc., to Virginia, Maryland and points north, while the melon growers of Virginia, later on, supply the Georgia and Florida markets when their crops have become exhausted. This condition is only made possible by cheap and prompt transportation, and the extent to which it may be developed is difficult to foresee.

It was well said by Wellington in his Economic Theory of Railway Location that in planning a railroad there are three ends to be attained:

"1. To sell all the transportation possible.
"2. To dispense with all the train miles possible.
"3. To reduce the cost of running trains per mile.

"As respects freight traffic, rates must in the long run be made equal, not simply from station to station, but from the door of the

consignor to the door of the consignee; in other words, all additional cost for cartage or switching service, and something more as compensation for the trouble (usually a very considerable addition) must be borne by the railroad before it is in a position to compete at all."

The terminal problems confronting railroad managers are usually, correcting errors previously made, or perhaps more generally, providing facilities at an enormous cost which could have been furnished when roads were built, at a moderate cost. In some instances these omissions were due to lack of foresight; in many cases, however, to the paramount desire of running a line to a large terminus and failing to provide sufficient funds to carry the line well into it.

Wellington says:

"Had it not so often happened that roads which have expended millions for the construction of long lines to a certain place have then begrudged or failed to raise the necessary additional money to carry their line into it, contenting themselves with hanging to the skirts of the town somewhere, where they can be reached by horse-cars or hacks and drays, it would seem incredible that business corporations could so frequently commit an act of folly which can fairly be paralleled with that of building a long bridge and erecting every span but one — assuming, on account of some difficulty with foundations, or what not, that a ferry would be good enough for that, because it would be 'such a little one.'"

There have been notable exceptions to this policy and these are the lines which are now successful in making money on freight traffic at the low rates now prevailing. As a result we are now adding to, revising or remodeling existing yards, while the creation of new yards is not so frequent. For this reason the "ideal" or "model" yard is mainly interesting in that it affords a guide for the revision, extension, remodeling or adaptation of existing inadequate yards.

The relative importance of terminals and main line, in point of cost of operating and lineal feet of rail in use, has been given. In the capital invested the disparity is greater. The terminals alone represent a greater amount of money than the remainder of the properties of the roads. This holds good when we leave out the smaller or intermediate stations and treat only of the great water terminals and general internal distributing centers, known as division terminals or yards. Their relative value in the countries of Europe is

necessarily even greater. In England alone hundreds of millions have been spent in remedying initial errors to enable successful transportation lines to reach the centers or interiors of great cities. Millions have been spent by the Pennsylvania Railroad Company to improve its terminals at Jersey City, Philadelphia, Pittsburg, and other points and apparently the work must go on for years, and this notwithstanding the fact that its management has always been broad, liberal and more farsighted than most in providing terminal facilities.

CHAPTER II

TERMS AND DEFINITIONS

For many years there was diversity of usage among railroad men as to the meaning of terms and the names of certain parts of railroad cars. The author recalls numerous instances where he has been compelled to ask conductors or yardmasters if, in telegraphing for a "pair of trucks," one truck was wanted or two; this because people varied in thinking of a truck as one thing, or of two axles as "a pair." The Master Car Builders' Association helped out mankind generally and the railroad world particularly when it caused the Car Builders' Dictionary to be prepared and published by the *Railroad Gazette*. While we still have with us the conductor and the yardmaster who will ask for "a pair" of trucks when only one is wanted, it is possible to educate them and there is an authority for their education.

The American Railway Engineering and Maintenance of Way Association, in 1901, made a list of terms, with accompanying definitions, relating to terminals or yards. Although there are some slight defects and false terms used, its adoption is earnestly recommended. Changes will be made from time to time and the nomenclature will be simplified and made more logical. We may, for example, hope for a substitute for the word "Cluster." The terms "Ladder," "Leader," "Lead-track," "Pulling-in-track," "Cross-over," "Head-track," etc., have been indiscriminately used and each has been applied to the track now known as a "ladder." The railroads might include this list of definitions in brief form in their operating department rule books. This would aid in bringing the men to a common understanding. These terms will be used in the following pages.

The Committee of the Maintenance of Way Association makes the preliminary explanation that the word "Terminal" has been taken to include all the facilities provided for terminal work on a large or small scale, while the word "yard" relates

only to one set of the tracks which are used for the switching or storage of cars. Terminals may be divided into freight or passenger terminals, and may be further classified as line terminals, division terminals, district terminals, branch terminals, etc., and with this explanation the following list of terms and definitions is presented.

Terminal. — The facilities provided by a railroad for the conduct of its business at the end of its line, or of a division or a district.

Freight Terminal. — The special arrangement of terminal facilities for handling freight business.

Passenger Teminal. — The special arrangement of facilities for handling passenger business.

Yard. — Three or more parallel tracks arranged in series for the convenient switching or storage of cars.

Receiving Yard. — A yard for the reception of traffic.

Separating Yard. — A yard next in order to the receiving yard, in which the traffic is separated by districts or commodities, as may be required.

Classification Yard. — A yard next in order to the separating yard, in which the traffic is classified in accordance with requirements, and made up into trains.

Departure Yard. — A yard next in order to the classification yard, in which trains are placed awaiting departure.

Storage Yard. — A yard in which cars are held awaiting disposition.

Cluster. — An arrangement of yards in series for the separation, classification and storage of cars.

Gravity Yard. — A yard in which the movement of cars is produced by gravity alone.

Assisting Grade. — The elevation given one or more tracks of a yard to facilitate the movement of cars.

Poling Yard. — A yard in which the movement of cars is produced by the use of a pole or stake operated by an engine on an adjoining parallel track. The movement may be facilitated by an assisting grade.

Summit Yard. — A yard in which the movement of cars is produced by pushing them slowly over a summit, beyond

which they run by gravity. The movement from the base of the summit may be facilitated by an assisting grade.

Body Track. — One of the parallel tracks of a yard upon which cars are switched or stored.

Ladder Track. — A track connecting in series the body tracks of a yard.

Lead Track. — An extended track connecting either end of a yard with the main line.

Drill Track. — A track connecting with the ladder and used exclusively for movements in yard switching.

Open Track. — A track reserved for movements through the yard.

Running Track. — A track reserved for movements through a cluster.

Cross-over Track. — A track connecting two adjoining tracks.

Special Tracks. — In a typical yard there will be several tracks devoted to special purposes, varying with the local conditions. These will include caboose tracks, scale tracks, coaling tracks, ashpit tracks, bad-order tracks, repair tracks, icing tracks, feed tracks, stock tracks, transfer tracks, sand tracks, depressed tracks, etc.

In connection with this general subject the definitions prepared by the American Railway Association, relating to main tracks and train movements and having some bearing on yard work are given below:

Train. — An engine, or more than one engine coupled, with or without cars displaying markers.

Regular Train. — A train represented on the time-table. It may consist of sections.

Section. — One of two or more trains running on the same schedule, displaying signals or for which signals are displayed.

Extra Train. — A train not represented on the time-table. It may be designated as:

> *Extra.* — For any extra train, except work extra.
>
> *Work Extra.* — For work train extra.

Superior Train. — A train having precedence over other trains.

A train may be made superior to another train by *right, class* or *direction.*

Right is conferred by train order, *Class* and *Direction* by time-table.

Right is superior to *class* or *direction.* *Direction* is superior as between trains of the same class.

(Note. — Superiority by "Direction" is limited to single track.)

Train of Superior Right. — A train given precedence by train order.

Train of Superior Class. — A train given precedence by time-table.

Train of Superior Direction. — A train given precedence in the direction specified in the time-table as between trains of the same class.

(Note. — Superiority by "Direction" is limited to single track.)

Time-table. — The authority for the movement of regular trains subject to the rules. It contains the classified schedules of trains with special instructions relating thereto.

Schedule. — That part of a time-table which prescribes the class, direction, number and movement of a regular train.

Main Track. — A principal track upon which trains are operated by time-table, train orders or by block signals.

Single Track. — A main track upon which trains are operated in both directions.

Double Track. — Two main tracks, upon one of which the current of traffic is in a specified direction, and upon the other in the opposite direction.

Current of Traffic. — The direction in which trains will move on a main track, under the rules.

Station. — A place designated on the time-table by name at which a train may stop for traffic; or to enter or to leave the main track; or from which fixed signals are operated.

Siding. — A track auxiliary to the main track for meet-

ing or passing trains, limited to the distance between two adjoining telegraph stations.

Fixed Signals. — A signal of fixed location indicating a condition affecting the movement of a train.

(Note. — The definition of a "fixed signal" covers such signals as slow boards, stop boards, yard limits, switch, train order, block, interlocking, semaphore, disc, ball, or other means for indicating stop, caution or proceed.)

Yard. — A system of tracks within defined limits provided for making up trains, storing cars and other purposes, over which movements not authorized by time-table or by train order, may be made, subject to prescribed signals and regulations.

Yard Engine. — An engine assigned to yard service and working within yard limits.

Pilot. — A person assigned to a train when the engineman or conductor, or both, are not fully acquainted with the physical characteristics, or running rules of the road, or portion of the road, over which the train is to be moved.

CHAPTER III

General Principles of Design

The business of a freight carrier is to move freight from one point to another for a consideration, and the least and cheapest possible handling enables it to do this at a profit. As rates are usually rigid, with a tendency to decrease, the only way to increase the margin of profit, and in many cases to create a margin of profit, is to reduce the cost of transportation. One of the best ways, if not the very best, to cheapen cost is reducing the number of cars needed to handle the business. With the per diem method of reimbursing foreign roads for the use of their cars, this holds true absolutely. It was frequently possible, under the old mileage system, to hold a number of cars on tracks without expense, beyond the interest on land and tracks occupied and, doubtless, this is the principal reason why so many tracks in yards were operated in an expensive and awkward manner for storage instead of being revised for motion. Under present methods of per diem payments, cars standing around unnecessarily are a daily loss and a drain on the margin of profit. By reducing the number of cars used, the cost of handling is reduced, and as already explained, this holds true whether a road uses its own or foreign cars. A road handling its business with the fewest cars possible is being well handled. All good operating methods and principles dovetail into this.

To reduce the number of cars in service a road must handle them promptly. They must be moved over the line at the economical speed that has been found suitable for the characteristics of each part of a line. The penalty for detentions can now be figured down to a penny, and it does not require much detention, due to congestion in terminals, awkward or reverse movements, etc., to run up into large amounts by the end of the month.

One railroad company took records on three separate occasions and found that from 81 to 84 per cent. of all the

cars on the road at the precise time the records were taken were not in motion. In the ordinary course of business, cars in good order stand in yards from 3 to 10 hours, this being something like the time needed to haul them to the next division terminal. In busy periods, then, it would seem that good-order cars should be kept in motion about half the time; but they are not, and there is an immense profit in working to approximate this ideal condition. For example: In a terminal handling 4,000 cars a day an hour's reduction in standing, effected either by improvement in design or operation, makes a daily saving of the time of 166 cars, which at the present per diem rate amounts to $33.20 per day. Assuming 10 per cent. of the cars to be "penalized," a saving of $12.80 would be added, making a total saving of $46 per day. This is often attainable and justifies expenditure and work in improving the layout and methods of working.

Most of our larger freight terminals are examples of evolution from smaller to larger yards. Like Topsy they "jest growed." Additional tracks were hung on wherever there happened to be a vacant piece of land and where the least grading was required. In many cases it was necessary to get anything that could be had and at any place available to avoid congestion or blockade. It was, however, due often to lack of foresight. The bill has been paid many times over.

An entirely unlooked-for enterprise, with no apparent connection with railroad work, may revolutionize the methods of handling or delivering freight at a terminal. As an illustration of what may be expected, the construction of the tunnels under the city of Chicago and the methods followed in originating the scheme, are most interesting. As they represent a new departure in terminal delivery methods and something to be anticipated, possibly, at other points it may not be amiss to briefly describe them and their purposes.

The promoter of the company now constructing these tunnels applied to the city for the right to run telegraph and telephone-wire conduits under all the streets in the business section. The existing telephone company violently opposed the application, but "public sentiment", carefully worked up,

favored the promoter's scheme which promised competition. The existing telephone company then apparently ceased opposition, but with skilful guile succeeded in imposing on the grant a lot of conditions as to size and strength, and made it so costly that the promoter's charter, when he got it, was worthless. The promoter and his associates bewailed publicly, while with wonderful skill and energy they for more than a year secretly pushed the tunnel shields along under the streets before it was known that a novel system of transportation, giving access to the basements throughout the business district was well under way. The company has changed its name twice and secured grants to permit of extended business. The Illinois Tunnel Company recently purchased at a cost of $2,500,000 about the only remaining available site for a terminal railroad station. It is said that upon this site $4,000,000 will be expended in the erection of buildings for storing and handling freight. Through this depot, connected as it will be by their extensive underground system with all the leading railroads, they expect to handle most of the freight which is now transported by means of drays in the center of the down-town business district. The proposed depot is to be 12 stories high; seven above and five below the surface of the ground. The five stories below ground will tap the various tunnels which radiate from this point in all directions. It is claimed that by means of the belt line and the tunnel system, connection will be had with 35 per cent. of the terminals of the country. In addition to connections with the belt line and tunnel system, the new depot will have a river frontage of 404 feet, enabling transfer of freight between the lake boats and down-town points. It is claimed that teaming will practically be done away with in the down-town district when the Tunnel Company's plans are perfected, and this will not only relieve the congestion on the streets but greatly facilitate the handling of freight. A general storage business and erection of coal warehouses are also contemplated.

It is important before proceeding with the plans for a terminal to make a study of traffic conditions as they exist and as they will probably exist years hence. After this has

been got at as accurately as may be, committees should be appointed, and a study of all conditions made. An examination of available plans of yards already in operation or building will be valuable. With this information, a summary should be made of the number of cars moving to and from each of the divisions centering in the terminal and to and from the industries and other unloading points. These figures should show the number of loaded and empty cars, and the number of trains, from which a tabulated statement may be worked up, including the average number of cars to a train in each direction and the maximum number of cars to a train. In some cases it may be well to go more into detail as to the number of cars in a train; tabulating for each division and each direction, the trains with fewer than ten cars; those between 10 and 20; between 20 and 30, etc. Figures of movements during certain hours or periods of the day may be advantageous. From these data a fair estimate may be made of the capacity needed for each receiving, separating, classification and departure yard, and the length and number of tracks required. Consideration should be also given to the possibility of adoption of a different class of road locomotives on any of the divisions or of a transfer or an exchange of power affecting the length of trains hauled.

Notwithstanding the fact that no two terminals can satisfactorily be constructed on the same plans and that local conditions govern largely, there are a few general principles which should be considered and which may be applied wholly or in part to the design.

General location of main passenger tracks, preferably dividing and running around the terminal in such a manner as to contain the yards between them. The next best plan is to throw them over to one side. In this, and in other points, the probable or future growth of the terminal must not be lost sight of.

Long inlet and outlet leads for freight trains, controlled at the extreme ends by interlocking plants enabling incoming trains to clear the passenger tracks at the nearest practicable point on the main track and at comparatively high

speed and permitting outgoing trains to clear the yard, avoiding interference with yard work and getting as far along as possible on their way to destinations, while awaiting the departure of passenger or other superior-right trains.

Number of classifications required; number of cars to each; average run of cars to a "cut" and total number of trains and cars to be cared for in each yard.

Kind of ladder to be used and location; if summit switching, location of the summit, etc.

Ample running and open tracks and locations.

Location of water pipes, ash tracks, roundhouses, coaling plants, etc., at convenient points.

Location of scales at most advantageous points.

Number of repair tracks, length and location.

Location of yard, number of tracks and length for cars held for orders. The tracks should not be too long; preferably they should be connected at both ends.

Length and location of caboose tracks; preferably gravity tracks to enable road engines and crews to get out their own cabooses, without delay and without the assistance of yard engines.

Separate tracks for engines to and from the engine-houses and attendant facilities to avoid interference. These tracks should be, as far as practicable, independent of tracks used by yard engines.

Telephone service, connecting telegraph offices, interlocking towers, engine-houses, crew dispatcher's and yardmaster's offices with each other. A local exchange is convenient and is a time and money saver.

Avoidance of curves, when possible, in body tracks.

Keeping switches together; avoiding use of slip switches.

Electric lighting, especially on ladders and avoidance of shadows.

Arrangements to separate fast freight from ordinary freight.

It is well to avoid unusual length of classification or assorting tracks, and where the classifications are numerous no attempt should be made to provide a track for each classifica-

tion. In such cases a second classification yard beyond the first, reclassifying from one of the tracks in the first into the second yard, would be the wiser plan unless a yard of enormous proportions is planned. With a "V" ladder possibly 30 to 36 tracks may be economically used, one half running from each ladder, but in practical working it may be desirable to reduce the number to about 20 tracks and reclassify into a second yard.

Under the Safety Appliance Act requiring each freight train to have not less than 50 per cent. of its cars air-braked and working and all other air-braked cars in the train associated with them, coupled up and working, the switching problem has been very much complicated. A yard now needs nearly double the number of classification tracks heretofore required. It would probably pay the railroads to equip the remaining non-air cars with air-brakes so that all cars would be under the control of the engineman.

In many plans of "typical" terminals the yards for each direction lie alongside of each other. This arrangement is objectionable in that the engine-houses, coaling plants, ash tracks, etc., as well as repair tracks, must be inconveniently located for one yard, or must be duplicated. An engine coming in from a westbound train must travel to the east end of the eastbound yard to get its return train, and a similar movement in the opposite direction must be made by the engine arriving on an eastbound train. By locating the yards so that they will "head in" on each other, *i. e.,* having the west end of the westbound yard terminate near the east end of the eastbound yard, the engine-houses and attendant facilities can be located where they may be readily reached by incoming engines from either yard and the facilities for caring for engines may be concentrated. This also applies to the organizations and men employed. This plan reduces the engine mileage and cuts out the running tracks needed for engines going to and from their trains. The caboose tracks should be located where the cabooses will not be disturbed in switching, as the men frequently use them for sleeping quarters. As some crews are usually assigned to regular or preferred runs, such as fast

freights, local or work trains, it is desirable to have two caboose tracks, and they should preferably be located near the outlet end of the terminal to enable the "pooled" or "first-in—first-out" crews to drop their cabooses to the rear of outgoing trains.

To enable compliance with the Safety Appliance Act, and at the same time get full service out of road engines, an air-testing plant is essential in the departure yards of each terminal. Here brakes may be tested, all leaks closed, repairs made and auxiliaries charged with full air pressure before the road engine arrives. A saving of much valuable time of engines and crews is thus effected. Brake apparatus can be better maintained and trains will be started out in safer condition than when the repairs are hurriedly made after the engine has coupled to the train and pumped up the pressure in the main train line and auxiliaries. Usually the repairs are neglected when the men are hurried. The cars on which brakes are non-operative are either cut out and air worked through (a very bad practice) or the cars are switched out, and put in the rear of the air-braked cars. This causes the loss of the braking power of those cars and delay to road engines and crews while the change is being made. After this switching the air again has to be tested. A testing-plant is not very expensive; usually one line of pipe can be run from the compressor across the end of the yard and connection with a hose coupling made between each two pairs of tracks; two tracks being reached with each coupling.

Repair tracks should be located at points where cars can be run directly into them from the receiving yards, the same as other cars being classified. The usual method, and that prescribed by the rules of the American Railway Association, is to place an inspector's blue flag in advance of the cars being worked on. This is to prevent engines or cars from coming in contact with the cars on the repair track and possibly injuring the men under or about the cars engaged in repair work. A better and safer plan is to put special locks on the switches of one-half the repair tracks, letting the foreman of the repairers alone have possession of the key. The yard men

will then put cars in one-half the tracks while the repairers are working on the other half. When the cars are ready to be taken out the foreman removes the special locks and places them on the switches of the tracks last filled, enabling the yard men to pull out the cars repaired and make room for placing other bad-order cars. Repair tracks should be short; they should hold not to exceed 15 or 20 cars each. This requires tracks longer than is usually figured for that number of cars, as bad-order cars are usually separated several feet to give repairers an opportunity to get around them conveniently. They are laid in pairs, about 16 feet center to center, and a clear space between each set or pair of about 25 or 30 feet for placing and handling material. A narrow-gage track may be laid in the wide space and small trucks for handling material run thereon. Small turntables are used to connect them at one end of the repair yard to a cross track leading to the material yard and supply house. The author has had two or three tracks set aside from the body tracks of a separating yard to be used for light repair work. These were planked over to enable wheels to be rolled and material handled. One track was cut out for material, including wheels. This arrangement worked very satisfactorily as it saved time in movement of cars and switching, and it relieved the regular repair yards of light work which interfered with making heavier repairs. In one yard a track alongside of the repair track was reserved for repairs to cars in fast freight and stock trains, and this prevented and reduced many delays. Wheels were put under stock cars in 20 minutes without any special exertion and cars were forwarded in the same train in which they arrived. Under the old method they were taken over to the regular repair yards and forwarded by later train. This usually resulted in 6 or 8 hours' detention and at times twice as long.

The scales should be located on the lead over which all cars are passed on their way to the ladder of the classification yard. They should, in every case, be provided with a "dead track" to avoid unnecessary strain on their bearings. If but a small proportion of the cars handled need to be weighed, or

if only cars for a few tracks in the classification yard need weighing, the scales may be located to better advantage on the ladder of the classification yard in advance of two, three or half a dozen of the body tracks as circumstances may require. There is a disposition to make scales too long, rather than too short. The long scale is objectionable as it necessitates keeping cars far apart, which delays switching.

Engine-houses and their coaling plants, sand plants, ash pits, water stations and turntables should be located in such a position as to prevent movements of engines to or from them, or from one part to another, from being blocked by the movements of road trains or yard engines. In some yards it is necessary, unfortunately, to have these light engine movements cross the main tracks, and where this occurs, the engines should be in charge of regular road runners and the movements should, if practicable, be under the control of interlocking plants. Where the terminals for the two directions are on the "lap" plan, or head into each other, the engine-houses, etc., can advantageously be concentrated at one point to serve engines from two or more divisions at the lowest cost and with a minimum of delay. The usual movement for an engine coming in from the road is to go to the ash-track first and have its hoppers dumped and fire cleaned or drawn. A hostler has a better opportunity to work on the fire when the tender is empty as he can use the long-handled tools to better advantage, having more room. Then, too, if the fire is to be drawn, for wash-out of boiler, repairs or other reasons, the engine is not loaded up with a tank of coal which may not only be in the way and prevent repairs to the tender, but is objectionable in other respects if the engine is to be laid up. The author once saw several steel-tired wheels completely ruined after having stood under a tender loaded with bituminous coal for two or three months. Rain had run through the coal and caused a constant drip of water containing sulphuric acid which cut considerable depressions into the steel tires and necessitated their removal.

The ash-track is usually elevated, sometimes on columns, and has a depressed track alongside for empty cars into which

the ashes are loaded. The engine's next movement is from the ash-track to the coaling plant, and it should either take sand and water while taking coal, or at some convenient point close by. In some cases, engines have their fires cleaned and ashes drawn while taking coal, a conveyor system being used for elevating coal as well as removing the ashes. The engine is then run over the turntable and, if necessary, into the roundhouse. The movements from roundhouse to coal plant should not conflict with those in the opposite direction.

While the above is an outline of the usual handling, there are exceptions, and these exceptions are the disturbing elements not only in handling engines but in all transportation work. An engine is needed for an assigned run, a fast freight or stock train, a passenger engine, or an engine for a work extra. Even the yard engine, with its crew waiting in idleness needs special service and attention. These have to be run around others and this means extra work and a corresponding or greater delay to other power to be handled. It is this same exception that breaks up the arrangement for handling cabooses in a regular manner, and that causes the fast freight to take precedence on the road over trains of more weight, frequently of greater value and certainly earning more money. It is necessary, therefore, to locate the ash-tracks, etc., in such a position as to enable one engine to be run in ahead of another. To this end the facilities for cleaning fires, coaling, taking water, sand, etc., may be advantageously located so they can be reached either from the outgoing track or the return track. A depressed track under a switching summit may be utilized to enable light road engines to cross from one side of a switching yard to the other without interfering or being interfered with. This idea may well be given consideration in connection with the design or revision of a busy terminal. Tracks used for light engines exclusively require little overhead clearance, and comparatively steep grades may be introduced to attain the very desirable condition of free and uninterrupted movement of road power. Loss of use of road power during "rush" seasons is extremely costly. Its value at such times is many times greater than when lying on sidings "white

leaded" awaiting a freight movement, and it is just at such times that terminal delays in the handling of power are most excessive and exasperating. Every facility should be provided to take care of engines promptly during heavy traffic periods, and to prevent yards from choking up at such times. All calculations for terminal work and elsewhere should be made to meet the requirements of the months of heaviest traffic movements. It may be wiser, in places, to base calculations on the heaviest day's movement. The remaining days will then have been provided for.

CHAPTER IV

Designing Terminals

A special committee of the American Railway Engineering and Maintenance of Way Association submitted a long report on "Yards and Terminals" some years ago from which the following extracts are taken as a basis of discussion:

Location. — The location of terminal yards should be convenient to the business terminal of the railroad, to the freight houses, team tracks and to the points of interchange with other roads or divisions, and should be arranged so that trains can enter or leave the yard without crossing the path of other movements. When possible, advantage should be taken of natural grades to assist switching. In some locations assisting grades cannot be had; in others, grades can be had in one direction; while in others, grades can be used to help in each direction. The assistance of grades is an advantage.

Receiving Yard. — Considering first a line terminal at the actual end of a railroad company's line. In the receiving yard, the road engines and cabooses are cut off and the work of assorting and distributing the cars is turned over to the switching engines and crews. The proper length of tracks depends on the unit selected and is governed by the following factors:

1. Length of train of loaded cars.
2. Length of train of empty cars.
3. Average length of trains.
4. Number of trains of average length per day.
5. Number of trains of maximum length per day.

Consideration should also be given to prospective changes in grade and to a possible increase in the length of trains entering the yard. The length of train is the controlling factor and the logical unit. When the number of trains of maximum length is less than 20 per cent. of the total number of trains entering the yard daily, the average train length is the most practical basis for a receiving yard having tracks of equal length. The yard may, however, be made with a portion of the tracks of sufficient length for maximum trains,

and the remainder of the tracks of sufficient length for average trains. In this case the tracks of each group should be of equal length, whichever unit is taken (the maximum or the average train). The track should be of such length as to accommodate a train with two engines and a caboose. If the average train length is taken as the unit, the length of track should be such that a train of the maximum length can be disposed of on not more than two tracks.

The proper size of a receiving yard depends on:

1. The frequency of the arrival of trains.
2. The rate at which cars can be received and disposed of in the separating yard. The receiving yard, however, should have a sufficient number of tracks to hold the trains arriving during one hour of maximum traffic.

Separating Yard. — This yard is the second in the series, and here the first breaking up of a train and the distribution of its cars are effected. The cars entering the yard are usually distributed so that according as the separations are to be by districts or commodities, the cars destined to assigned districts, or containing the same commodities, will be placed together on separate tracks. The yard should be located in advance of the receiving yard, and in such a way that cars can be readily moved into it. The number of tracks in the separating yard should be governed by the number of separations to be made. The length of these tracks should be determined by the number of cars for each separation, and there should be extra room allowed for emergencies.

Classification Yard. — When the separation in the preceding yard is by districts, the purpose of the classification yard is to put the cars of the different districts in regular order. The cars of each district (already placed on one of the tracks of the separating yard) are switched in the classification yard in the order required for delivery at destination. When the separation is by commodities, the cars of each commodity (already placed on one of the tracks of the separating yard) are further assorted by classes or grades. Thus all the cars of grain placed indiscriminately on a track in the separating yard will be rearranged in the classification yard so that the cars of wheat, corn, oats, etc., are each grouped on sepa-

rate tracks. The classification yard should be located in advance of the separating yard, in such a way that cars may be readily moved into it from any of the tracks of the latter yard. It is usually in the form of a gridiron, and its capacity will be determined by the number of cars going to a district, with allowance for an excess number or for emergencies. As an example: With 36 cars going to a district, two "gridirons" of six tracks each with a capacity of six cars to a track, will give such control to the entire set of cars that it can be turned end for end, or car for car. This type of yard may be made up of a series of parallel stub tracks instead of gridirons. Such an arrangement is sometimes termed a "lancing yard."

Departure Yard. — Here the work of the yard engines and their crews ceases, and that of the road or transfer engines, and their crews, is begun. It should be located in advance of the classification yard, so that cars from all tracks in the latter can be readily moved into the departure yard. The number of tracks and the length of tracks in this yard are governed by the same requirements as those governing the receiving yard.

Storage Yard. — The location is important and depends almost entirely upon the character of the cars to be stored or held. Three distinct cases may be mentioned:

1. On some railroads it is known in advance that entire train loads arriving will have to be held. In such cases, the storage yard should be located with, or in close relation to the receiving and separating yards, so as to permit of direct movement of trains to the storage yard, and then to the separating yards as required.

2. The cars to be held may arrive mixed in with cars that are to go forward. In such cases the storage yard should be located in relation to the separating yard so that the cars can be moved directly into the storage yard from the separating yard, and then delivered to the classification yard as required.

3. The character of the freight to be held may be such that it can be put in district and station order at once. In such cases the storage yard should be located in such relation

to the classification and departure yards, that cars can be moved directly into the storage yard from the classification yard and then delivered to the departure yard as required.

There are probably other cases, but three of the principal ones have been mentioned to indicate the fact that the location of the storage yard cannot be determined arbitrarily or theoretically but must be determined by the character of the business in each case. The size should be governed almost entirely by the number of cars to be held and the length of the tracks should be such that a switching engine can readily handle all the cars stored on one track.

Body Tracks. — These should be spaced 11 ft. 6 ins. to 13 ft. center to center, and while the minimum spacing is not recommended for general use, it is often necessary in city yards. At intervals of five or six tracks an extra width of spacing should be given, in order to allow space for drainage and for piling track material, etc. It is also advisable to allow a space of 15 ft. between the center of a main track and a yard track, to give ample space for water columns or standpipes, signal posts, etc.

Ladder Tracks. — Where there are two ladder tracks or where a yard track parallels a ladder track, these tracks should be 15 ft. center to center. The extra room is required for the safety of trainmen in throwing switches and moving in and out between the cars. The angle which the ladder track makes with the body tracks should be the greatest angle which the frog used will allow. A No. 7 (8° 11′) should be the minimum number of frog for yard use. Frogs of higher number are preferable and are often used, but it must be remembered that the easier curves of such frogs require longer leads and consequently require more yard space.

Lead Tracks. — The connection of these tracks with the main line should be controlled by a telegraph or telephone office and interlocking plant, both for safety and to facilitate train movements.

Drill Tracks. — These tracks should be so located as to cause a minimum interference with other movements.

Open Tracks. — The track selected as the open track

should be one that will enable movements to be made from one end of a yard to another with the greatest convenience.

Running Tracks. — Tracks of this class should be provided for movements in each direction, to enable yard engines to pass freely from one portion of the cluster to another, also for road and yard engines to get to and from the engine-house and other points where facilities are located.

Other tracks are required for special purposes, sufficiently indicated by their names. Several of these have been enumerated in the list of definitions already given, and particulars as to some of them are given below:

Caboose Tracks. — Cabooses arriving at a yard usually return over the same division, instead of going forward. It is, therefore, usually necessary to locate caboose tracks between the receiving yard and the departure yard, and to arrange them so that the cabooses can be readily pushed from a receiving track to the caboose track, and then dropped by gravity to a train departing in the direction from which the caboose has arrived. There are various ways in which this can be accomplished, but in locating these tracks care should be taken that only a minimum amount of switching will be required. The tracks should be so arranged that cabooses feed "first in — first out." Occasionally special tracks must be provided for the cabooses of fast freight trains.

Scale Track. — This is usually located between the receiving and separating yards. It is undoubtedly the best location for automatic weighing, and no reverse movements should be required in taking the cars on and off the scale.

Coal, Ash-pit, Sand and Engine Tracks. — The engine coaling apparatus is usually located on the track leading to the engine-house. Water and sand should also be taken at the same time as the coal where it is possible to arrange this. The facilities for supplying coal, water and sand are sometimes provided on the outgoing engine-house track, as well as the incoming track. It will be of advantage to provide a run-around track, so that switch engines may clean fires, take coal and water and pass around waiting road engines.

Bad-order Tracks. — These are required so as to get

the bad-order cars out of the way of the switching movements, and they should be arranged for easy access at all times. From them the cars are taken to the repair tracks.

Repair Tracks. — These should connect with the bad-order tracks, where practicable. They should be laid in pairs, 16 ft. center to center, with a space not less than 24 ft. between each pair for the handling of material. The capacity of repair tracks should not ordinarily exceed 15 cars.

Icing Tracks. — These should be between the receiving and separating yards, so that the cars to be iced may be readily moved from the receiving yard to the icing track and thence to the separating yard.

Other Special Tracks. — The particular purpose for which such tracks are required should be considered, and they should be so located that their use will involve a minimum amount of switching and the least possible interference with the regular yard movement.

In presenting its report the Committee considered the designing of a yard with reference to the movement of traffic in one direction only, and for movements in the opposite direction, a duplication of yard facilities would be required. In planning terminals to accomplish certain purposes in connection with the railroad's business of getting a loaded car to the unloading point with the least possible delay, and an empty car to the loading point as rapidly as practicable, the remarks made by the American Railway Engineering and Maintenance of Way Association's Committee on Yards and Terminals, and published January, 1903, under the heading "Terminal Yard and General Switching" are interesting:

"The actual practice in the methods of operating the switching traffic, or switching movements of such yards and terminals varies at different yards, owing to the local conditions of yard plans and traffic. The proper handling of traffic is largely a matter of individual ability, and must be governed to a large extent by the peculiarities of the traffic and the physical characteristics of the yard. For these reasons, therefore, the operation of the switching traffic can only be dealt with in a general statement.

"A terminal is composed of the facilities of a railroad in a city for handling its business, and usually embraces all the tracks and facilities. The distance from the large general yard or cluster to the docks, wharves, freight houses, team tracks or other facilities

is in some cases as much as 15 or 20 miles. This territory is divided into districts, for convenience in switching and for the assignment of switching crews. Each switching district is usually provided with a small switching yard, from which the various private side tracks, freight houses and manufacturing establishments in the district are supplied with their cars. The district yard is supplied and relieved by movements to and from the cluster to the general yard. These latter movements are made by what are termed 'transfer crews.'

"The movement of a train after its arrival at the general yard or cluster where the engine and caboose are detached is as follows: At large terminals the cluster is usually several miles from the city, and is the point at which all trains are received and dispatched. The manifest of the train is taken by the train conductor to the yard office immediately upon arrival; from this manifest a card is prepared for each car in the train by the train-carding clerk. These cards are prepared and turned over to the car carder, who takes them to the yard and tacks the proper card on one or both sides of the car. The cards have various colors, shapes, letters, monograms, marks, etc., designating the various districts to which the cars are to be moved. While the cards are being prepared and attached to the cars, the cars are inspected by the car inspector, so that they are ready to be moved as soon as carded.

"A yard engine and crew now takes the cars in charge and classifies them, either by drilling, poling or pushing them over a summit, thus putting the cars for each district on the track in the separating yard assigned to that particular district. After completing this work the engine in question commences work on another train. The conductor doing this work keeps no record of the cars handled. The next engine to handle these cars is what is known as a 'transfer engine,' and makes what is termed the 'interior and exterior' movement of cars; that is, movement from one yard or district to another (interior), or to the yards of various other railroads (exterior). When this engine takes a train to the district yard or to the yard of another railroad it has nothing more to do with the train and may return light to the cluster. If there is a return load at the yard in question, or a load can be picked up on the way back, this engine handles the movement. It sometimes happens that one of these engines will have freight for two or more districts as it proceeds. After the freight arrives in the district in which it is to be unloaded, some of it is held for orders of consignee, while other freight of the same lot may be switched to consignee without waiting for orders. That for the freight house and team tracks, if there is room for it, is delivered immediately, or as soon as convenient, after arrival. That part of the freight consigned to industries, for which there may be a number of other cars that may have arrived previously, will be held and placed in the order of its age, or ahead of its turn, according to the wants of the consignee. These latter movements are all made by the district switch engine; that is, the engine working in that district and doing the local switching.

"At nearly all clusters or general yards quite a large percentage of the business arriving consists of what are termed 'hold cars'; that is, cars which are to be held at the outer yard until the final destination or switching directions are given. On arrival, these cars are switched to the 'hold' yard, and are daily re-switched in order to

take from among them the cars for which directions for delivery have been received. When directions are received the cars are carded and treated just the same as cars which move directly to destination. The 'hold' car is a great nuisance, as large roads will frequently have 500 or 600 'hold' cars, and receive orders daily for 50 to 100 of them. These must be switched out from the entire lot, entailing a large amount of work.

"The movement in the reverse direction is made in practically the same way as the movement from the general yard or cluster to the industrial districts; that is, the district engine gathers up the cars for movement, a transfer engine takes them to the general yard, where they are switched to the outbound or classification tracks. Here the trains are made up in station order, the bills are prepared by the yard clerk, and the road engine finally couples on and the train is complete and ready to leave.

"At larger terminals, in order that cars may be readily located and not get lost, a record is kept as follows: The conductor of the road engine brings the train into the general yard or cluster and fills out a card, giving number and initials, kind, lading and condition of seals of every car in the train. The conductor or foreman of the transfer engine fills out a card, stating whether loaded or empty, and the point at which set off or picked up. The district switch-engine conductor makes a similar record for all cars moved to and from large industries. These cards are forwarded at once to the car record office and entered in the car record book, so that the record of any particular car may be found in the book by turning to the number of the car. Thus it may be found that it arrived at the general yard or cluster on such a date, and moved from the district yard to some industry on a certain date. The record may also show that the car has been reloaded from this particular industry and again moved to the general yard; or, if it does not show movement from the industry, the car is still on its tracks. Thus the location of any car at a large terminal may be ascertained in a few minutes.

"In the movement of outbound freight the cars are carded by the district or local yard clerk, who works under the direction of the local agent. The agent prepares memorandum bills, which are sent by train-mail or messenger to the general yard. At this point the bills are taken in charge by the yard clerk, who checks the train and prepares the train list and bills for the conductor, a bill or manifest being furnished to each car in the train.

"The movement of transfer engines, especially those working from the freight houses, is made on regular schedules. This is done so that immediately on closing the freight houses at night, cars are moved from them into the general yard, and cars for morning delivery are at the freight house before they open for business."

In outlining "Certain Considerations in Designing Yards," Mr. W. L. Derr, of the N. Y., N. H. & H., says:

"It should not be forgotten that it costs from 12 to 25 cents to switch a car through a yard. * * * The yard is one of the tools of the railroad. The thought devoted to its improved design, and the large sums of money expended in carrying out the plan to a successful completion, are primarily to bring the tool up to the greatest degree of efficiency, and thereby produce the work turned out by it

as economically, and in as short a time as possible; for the business of a railroad company is to manufacture and sell transportation, and the yard is one of the departments in the great establishment. It must do its share of the manufacturing economically, and not have its losses made up by another department."

Of late years, the common error of leaving the matter of design — both for new and for revising old yards — entirely to the Engineering Department (usually with insufficient data as to existing conditions and probable future conditions) and at other times, letting the yardmaster decide the whole question, has been largely rectified, and it is the general practice to get the fullest possible co-operation of the engineering and operating departments.

In a letter to the *Railroad Gazette* in 1893, Mr. A. Morrison said:

"It is well known that division terminal yards especially are grossly insufficient in capacity, and defective in design. It is a common occurrence to see the business in the yards butchered daily, so to speak, with a resulting universal obstruction to business and an enormous expense for switching or shifting. No railroad yard should be constructed without the engineer in charge taking advantage of all the information possible, to be gained from the superintendent down to the brakeman of the shifting crew; and while it is impossible for any civil engineer to have practical knowledge of all branches of railroading, still so long as he will continue to consider himself lord of all these practical branches, our yards will remain a discredit to intelligent railroad men."

The author has found in his dealings with civil engineers that they were more than willing to receive suggestions from operating men and to co-operate with them.

The fewest possible number of division terminals should be built, consistent with reasonable length of locomotive runs and the physical characteristics of the road, which frequently determine the point at which engines are turned. Handling locomotives at terminals is expensive. Where from 100 to 150 engines are turned a day the cost of handling ranges from $1.10 to $2.00 an engine. This does not include removing ashes from pits, handling coal, sand and water, or furnishing steam heat in firing up. The cost during severe winter weather or where boilers are washed out more than once in two weeks often exceeds these figures. The cost of turning an engine on the turntable depends on the power used to

move the table. With hand power the cost is from 4 to 8 cents an engine. Where more than 75 engines are turned in a day it is economical to install power-driven tables. If power is available it may be economical to use power-driven tables where only 35 or 40 engines are turned in a day. The cost of turning 250 engines a day is:

With electric motor without special dynamo	$3.92
With steam engine	4.40
With gasolene motor	3.95

This covers the cost of labor, fuel or current, supplies and repairs. The records of one road give the cost of turning engines by power at different points as follows:

	H. P.	Engines per Day	Average Cost Per Day	Per Engine
Gasolene motor	5	170	$3.78	2.22 cents
Gasolene motor	5	110	3.42	3.09
Gasolene motor	5	194	3.55	1.83
Gasolene motor	5	121	3.41	2.90
Gasolene motor	5	46	2.91	6.50
Electric motor	20	140	3.99	2.85

In considering the construction of new terminals or the revision or enlargement, or both, of those already in existence, the operation of the entire railroad should be carefully considered and the bearing of the particular yard or terminal in question on all other yards, and on the entire line, must not be lost sight of. In many cases it may be desirable, if not essential, to go beyond the limits of the road itself and study the methods, yards and character of traffic of immediate connecting lines, probable changes in character of traffic and methods of handling in the future. The construction and operating departments should confer closely and freely. It is usually wise to include a representative of the traffic department also, in order to obtain his views as to the necessity now and hereafter for faster time and more prompt deliveries. The traffic department should be consulted more especially with reference to the probable future volume of business to be provided for, its character and changes, direction, new routes to be opened up with a tendency to divert traffic from established routes to or from the lines carrying it through the terminal under consideration.

The author has in mind a case on a trunk line where a "yard" consisting of two long tracks, with a cross-over half way, sufficed for many years to enable changing of engines, inspection, etc., to be done with reasonable promptness for a comparatively heavy business. In the course of a few years the "yard" proved entirely inadequate and had to be increased to something like ten times its original capacity, although the traffic of the road had not increased in anything like this proportion; certainly not to exceed 15 per cent. This was due to the fact that the road originally handled a traffic consisting of about 80 per cent. of bituminous coal, requiring little or no separating or classifying, and only ordinary movement as to time. New connections and traffic arrangements, a thousand miles away, produced a condition by which the percentage changed and considerably more than one half of the road's traffic consisted of general merchandise freight, stock, meat, etc. This required different treatment.

The idea that when facilities are inadequate the only thing is to supply more track room should be abandoned. The tendency to "extend" yards or tracks, is in itself vicious. It often happens that a terminal containing small track room but well designed will pass more cars through it in a given length of time than a terminal having much greater track room. This should be studied, for it is a drain on a railroad's operating account to maintain a number of miles of track little used, or merely used for storage, because insufficient or awkward facilities prevent continuous movement. The interest charges on the material in such tracks, value of real estate occupied, taxes, etc., on property bringing in no revenue and serving no good purpose should be considered. An endeavor should be made to reduce the size of the yard, or terminal, to the smallest number of lineal feet of track; or, to so plan and construct as to have every foot of track serve a useful purpose, and serve such purpose in the most economical way. A mistake in design requiring unnecessary movements in a yard, or unnecessarily expensive movements, will, like Tennyson's Brook, "go on forever." The expense is continuous and difficult to overcome afterwards.

The study should, by no means, be confined to the one terminal under discussion. The conditions of the entire line should be looked into and a well defined policy mapped out. This is far reaching and needs to be exhaustive. Possibly some yards may be abandoned, some reduced, and expenses curtailed by improving conditions at one or more points. This needs a general study of traffic movements in volume, kind and direction for the present and far into the future, followed by a general policy as to the make-up of trains from one end of the system to the other, and in both directions.

There are some roads that believe in each division terminal doing its own switching, that is, to do only such work on trains as will carry them to the next division terminal without further switching; while others start their trains from the system terminals made up to go as far as practicable without rehandling. Each method is in vogue; each has its adherents and its good points; but there are cases where the switching is unnecessarily overdone through duplication. Occasionally these expensive methods are caused by inadequate facilities at vital points. It is greatly to be regretted, however, that it is frequently due to officers in charge of general train movements not fully understanding the situation in detail, or not having the time to study the train and yard movements and expenses closely enough to enable an intelligent analysis to be made.

It may perhaps be assumed that a road is working on a well defined and carefully thought-out policy regarding its freight divisions. Many instances, however, have passed into history where certain track changes, grade or curve reductions, shop installations, acquirement of additional track mileage, wage schedule changes, etc., have made it desirable or essential that a freight division be added or eliminated. A change of this kind has an important bearing on the terminals. If the probability of such changes cannot be foreseen with reasonable accuracy it is hardly wise to handicap a terminal in the least by providing for the remote possibility. What can be done, however, is to obtain an expression of opinion from the management bearing on this detail.

Not very many years ago an important railroad in this country was operating its main line in five freight divisions. As the physical characteristics and traffic conditions were favorable it was decided to operate in four divisions, with about 160 miles of line in each. The change was made. One division disappeared and the operating expenses were materially reduced. The troubles of the yardmaster, however, began. Naturally none of the old terminal yards, except those at the two ends of the road, were of any further service. They represented so much dead track. Yards were built at the new terminals, but the outlay required for roundhouses, etc., was so heavy that these yards were somewhat curtailed. Ample track room was provided in the course of time, but the trainmasters and yardmasters spent, in the meantime, many sleepless nights, and the business of the company suffered.

The future is hard to figure on. It is well, therefore, to preserve or provide the greatest possible amount of elasticity in the terminal. There are two general methods by which this can be done, provided property limitations, physical characteristics, etc., permit. The first plan is to design and construct the terminal so as to enable, in operation, a transfer of work during an abnormal rush of business or an emergency, from an overcrowded part or side of the yard, to another that perhaps is not worked to its capacity. Emergencies may include accidents on the line, heavy run of business in one direction or of certain kinds of freight, shortage of power on a certain division, bunching of power due to various causes, delayed passenger trains, etc. The other plan, which perhaps is more in the nature of an accompaniment than an alternative, is to design the terminal in such a way as to enable any of the yards to be enlarged at any time. This is a wise course, too, because of the possibility of unforeseen changes in traffic conditions in the future.

The doubling of the volume of freight traffic in the past eight years has made it necessary to limit the size of a yard and add others in series, and to avoid yards too large for economical and satisfactory operation. A paragraph in the Pennsylvania Railroad annual report for 1902 indicated this:

"Experience having shown that yards may become too large for the prompt and economical movement of traffic, these new yards will be used for coal, coke and limestone, and through the relief thus afforded, the Altoona and Harrisburg yards will be amply sufficient for the general merchandise traffic."

While there is some difference of opinion as to the number of body or classification tracks that can be satisfactorily operated from one "V" ladder, it seems that from 30 to 36 is the outside limit, and 20 a practicable working number. Mr. Cushing thinks 20 tracks enough for one V-yard, but that two such V-yards can be put together to form one classification yard, as was done at Fairview, near Harrisburg. He says the question really resolves itself into "What is the limit in size of a freight-yard unit?" A large number of units can be placed in proximity, provided the entrances and exits are so free that the movement to and from any one unit will not interfere with others, and it is, therefore, usually the ground available which limits the size of a collection of units. A unit is a receiving yard, a classification yard, a departure yard, with car repair, caboose and engine tracks. One set of departure, car repair, caboose, and engine tracks often serves two or more sets of receiving and classification tracks. The number of receiving tracks will depend on the density of traffic and liability to interruption from wrecks. After laying out one unit, care must be taken to avoid impairing its usefulness by placing another one so that the movements conflict.

An excellent plan was adopted by one railroad company a few years ago, when confronted with the necessity for revising some of its most important yards. The general manager appointed a committee consisting of the chief engineer, his principal assistant engineer, and the superintendents, engineers and assistant engineers of all the divisions entering the yard under consideration. The superintendent in immediate charge of the yard in question acted as the chairman, and the committee met once a week for two months, to prepare plans and report. The committee as a whole, during the first part of the period of its existence, visited large yards on the designing of which time and thought had been spent. The

sub-committees meanwhile prepared detailed information concerning the yard to be revised. The officers engaged in this were divided into:

(1) A sub-committee to gather all the statistics of the operation and traffic of the yard.

(2) A sub-committee to make various sketch plans to be discussed by the general committee.

(3) A sub-committee to read and abstract a number of the important articles on yard design and operation in the technical journals and books for the preceding period of 10 or 15 years. These abstracts were accompanied by sketches of yards described and in shape to be readily studied by the general committee.

After the preliminary work of obtaining statistics and preparing plans, the yardmasters and their assistants were requested to attend one or more meetings of the committee and were invited to criticise the plans. The committee also interrogated the yardmasters and men with a view to informing itself fully as to details.

So far as practicable cars should move continuously in one direction from loading point to unloading point. Reverse movements should be avoided, as they cause unnecessary mileage of cars and engines, loss of time to freight, interference with switching and road movements, etc., and additional wear and tear on rolling stock in stopping and reversing the direction of its movement. Considerable money can be spent to keep the movement continuously in one direction by reason of the enormous saving in operating.

On double-track roads, the terminal should be located between two main tracks, but this cannot always be done. Property limitations, topographical considerations, necessity of handling passenger business in the vicinity, errors in original design, making the cost excessive, and the location of engine-houses and coaling stations may prevent. Other things being equal, it is desirable at larger division and system terminals to entirely divorce the passenger and freight traffic. Where this can be done it is to the benefit of both, while the consolidation, necessary at times, is detrimental. This ap-

plies only to larger points where a reasonably heavy business is being handled. Where business is light it is usually economical to combine the freight and passenger business. At large system or line terminals it is of decided advantage to separate the passenger lines from the freight lines some distance in advance of the yards. When the passenger terminals are located near the center of a city, it is often advisable to run the freight tracks around, where yard room can be had cheaper. Better time can then be made with less liability of congestion. If tracks through the city are laid at street levels, the advantage of such an arrangement is apparent. The objection to separating main tracks around terminals, that enginemen cannot read signals carried by engines on trains in the opposite direction, is not a material one. Where such an arrangement of tracks exists, the entrances and outlets at either end of the terminal should be protected by operators in charge of interlocking plants, and outgoing trains should be governed by signals given them. By the separation of the tracks there is a minimum of interference through cross-over movements. Freight and passenger trains in the same direction use the same tracks, and no connection with passenger tracks need be made except at the two ends of the terminal or at the point where the four-track system converges into double track. But one side of the passenger train is exposed to the possibility of entanglement with accidents occurring on the yard tracks next alongside. This is a safer arrangement than dividing the terminal by having the passenger or high-speed tracks run through the center. In this plan, yard engines in charge of hostlers or going to or from their freight trains need not come in contact with or cross the high-speed tracks. Conversely, passenger trains cannot interfere with the movements of freight engines or detain them.

When the high-speed tracks, for any reason, cannot be run around the terminals, the next best plan is to run both on one side. As compared with the preceding arrangement this is open to the objection of compelling freight trains moving in one direction to cross the passenger tracks in the opposite direction when entering and leaving the terminal. It will be

seen that this will frequently compel freight trains to be stopped for passenger trains in the opposite direction, causing some detention and considerable expense. But one side of passenger trains in one direction is alongside of a yard track. As in the previous plan, the advantage exists of enabling interior terminal movements to be made from any yard to another, to or from engine-houses, etc., without interference with high-speed trains. Both plans have the decided advantage of enabling a transfer of work from one yard to another when one part of the traffic runs abnormally heavy or when emergencies arise. These transfers can be made without encountering the high-speed track movements at any point. The advantage of this is that a class of enginemen can be employed who may not be permitted to go out on the open road because of a lack of familiarity with train rules. There are always a number of such men at hand and in times of a heavy rush of business or abnormal conditions, it is usually difficult to secure men who can run on the main line.

To run the two main tracks through the center of the terminal, dividing the east or southbound side from the other, is often the only alternative, and doubtless there are more terminals operated on this plan than there are of the other two combined. The liability to accident is somewhat greater under this arrangement and there are many objections which have been briefly reviewed. There are, nevertheless, many who favor this plan as against running the two passenger tracks on one side because of the necessity of crossing movements in the latter. These movements exist in one form or another, however, as the engine-houses, coaling plants, repair tracks, etc., are usually located on one side and cross-over movements are made necessary, for road engines to or from the engine-house, cabooses to be returned from the direction in which they arrived, cars moving in one direction to be repaired, etc.

Mr. W. C. Cushing says in this connection:

"When it is not expedient, either from cost or other considerations, to carry one track over or under another in such a liberal fashion as in these two cases, it behooves the designer, be he engineer or transportation man, to dispose of his main tracks so that

there will be as little interference with main track traffic as possible, and of this improvement there are many notable instances.

"In the case of a four-track railroad which uses the two middle tracks for freight, the eastward and westward tracks should be separated so as to locate the yard in the center. The Conway yard of the P., F. W. & C. has just been remodeled on that plan, to avoid the delays to passenger and freight business incident to the former arrangement, which had become very annoying. When the passenger tracks are the two middle ones, they are generally in the center of the yard, but switching movements are all that interfere with main track traffic and they may or may not be troublesome. If they are, the remedy is to elevate the passenger tracks, and make a yard connection beneath. A design for a yard (not built), in a rather cramped and difficult position, prepared by the writer, illustrates the point. It was complicated by the necessity for passing streets below the yard level, but, on the other hand, the situation lent itself very well to the subgrade construction for the streets. There were two noteworthy features in connection with the plan, the ladder arrangement for the westward classification tracks, and the outward engine track, which turns engines without putting them on the table. The cabin cars were intended to be collected on a classification track, and then run around to their station on the same track, thus putting them in proper order.

"On double track railroads, it has become the practice in some instances to put the yards between the main tracks, unless there is some special reason for doing otherwise. Witness the new yards of the Norfolk & Western at East Portsmouth, Ohio; Roanoke, Va., and Williamson, W. Va. (*Railroad Gazette,* Sept. 25, 1903), and the Linwood yard near Cincinnati, of the Pennsylvania Lines, built in 1904.

"In many cases, however, this plan has been varied; (a) by leaving the main tracks on one side of the yard, (b) by putting one in the center and the other on the outside, or (c) by putting them both in the center. Yards built according to (a) are at Oak Grove, Pa., on the N. Y. C. & H. R. R. R. (*Railroad Gazette,* March 14, 1902), at Elkhart, Ind., on the L. S. & M. S. Ry. (*Railroad Gazette,* March 18, 1904), at 55th street, Chicago, on the Pennsylvania Lines, and at Alexandria, Va., on the Washington Southern.

"Putting both of the main tracks of a double-track railroad in the center of the yards is a plan much used, and is only objectionable when there is a large amount of interchange between the eastward and westward yards. These movements from one yard to the other can be made safely and quickly across the main tracks under the protection of an interlocking plant, until the business becomes too great. The Pennsylvania has built the jump-overs for that reason where they were needed. It is the writer's opinion that the center position is less objectionable than the position where both are on one side of the yards. The protection of crossing movements when in the center position leads us to the consideration of another mark of progress in yard design, though the improvement dates farther back than the beginning of the century. Nevertheless a great deal of attention has been given to it in recent years. This improvement is the locking up of yards where they have outlets into the passenger tracks, and placing a sentinel on guard.

"The most efficient guardian is the interlocking plant, though a telegraph station is a fair substitute. Yard men should not be allowed to dodge out on the main passenger tracks by cross-overs wherever they find them most convenient, but should only make a main track movement under proper permission."

In discussing a paper on "Design and Operation of Division and Tide Water Terminals," read by Mr. C. L. Bardo before the New York Railroad Club, December 18, 1903, Mr. Walter G. Berg said:

"Another important point is that trains that are to go into the yard or leave it should make those movements quickly. They should be got off the main tracks promptly when entering the yard. It is important to have approach tracks leading to the yard. The great mistake usually made is that the yard lead track turns out of the main line track. There should be an approach track or lead-in track approaching the yard switches proper, long enough to accommodate at least one train, so that if a freight train is just able to make the yard ahead of a passenger schedule it can turn in to the lead-in track quickly without having to slow down, or without fearing to meet possibly a switching engine or some yard operation and have to block the main line for a considerable time.

"Similarly at the departing end of the yard it is very important, especially when there is not a system of yard tracks known as a departure yard or advance yard, to have a track leading away from the yard out along the main track for some distance. There are cases where this lead-out track has been extended several miles advantageously. It means that when the train is boarded in the yard ready to leave, it is pulled out slowly into this lead-out track and goes out of the yard and away from it and then stops with the nose of the engine at the signal tower, at the head of the lead-out track, and when it gets the board it can rush out on the main line and make a quick run and get out of the way at the next passing siding."

The cost of stopping freight trains seems to have been given little study and is not fully understood. Many train masters, most train dispatchers, nearly all maintenance-of-way and yard men seem to labor under the impression that shutting off the engine throttle and again opening it is about all there is to the performance. In some cases they make an allowance for a few minutes of lost time. Exact figures covering the cost of stopping a freight train are not to be had. It depends on conditions of road, grades, weight of train, etc. There is perhaps no data of a more reliable or satisfactory nature than that given by Wellington in his "Theory of Railway Location" where he discusses the objections to grade crossings

from all standpoints, including that of the necessary stops to trains:

"Nevertheless from an economical point of view, abolishing the stops at grade crossings is by far the most important, especially when, as is so frequently the case, they reduce the number of cars hauled below what it otherwise would be. To reach this conclusion we need not adopt any of the wild estimates which give the cost of a stop anywhere from a dollar up. Without going elaborately into the details of the estimate, to discuss which properly by items would take considerable space, from 30 to 60 cents may fairly be taken as the cost of a stop, apart from all effect on length of trains. An estimate of 40 cents per stop for average trains on lines doing considerable through business can hardly be considered excessive, and at this rate the cost per year of each train per day stopping at the crossings is 365 × \$0.40 = \$146 per year."

A more recent estimate of the cost of stopping trains and the saving to be effected by installing interlocking plants was given in a paper by Mr. J. A. Peabody, read before the Railway Signal Association, in October 1905. He estimates the cost of stopping and starting a six-car passenger train from and to 45 miles an hour to be 35 cents and of a 1500-ton freight train from and to 15 miles an hour to be 56 cents, an average of 45 cents. Using this figure as a basis he gives the following examples:

Example 1.—Entrance to a yard from a double track; crossover, four derails, four high signals, six dwarfs.

Cost of interlocking plant complete		\$8,000
Interest on cost at 4 per cent	\$320	
Depreciation per year, 7 per cent	560	
Cost of maintenance per year	840	
Cost of operation per year	1,440	
Total cost per year	\$2,800	

Saving to be Effected

Trains per day.	Cost per year for stopping trains.	Total cost interlocking per year, as above.	Net saving per year.	Time required to pay for installation (\$8,000) from saving.	Saving—capitalized at 4 per cent.
17	\$2,800	\$2,800	.....	.....	......
20	3,285	2,800	\$485	16.5 yrs.	\$12,125
25	4,105	2,800	1,305	6.13 "	32,625
30	4,930	2,800	2,130	3.8 "	53,250
50	8,210	2,800	5,410	1.48 "	135,250
70	11,495	2,800	8,695	11 mos.	217,378
80	13,140	2,800	10,340	9.3 "	258,500
100	16,425	2,800	13,625	7.0 "	340,625

Example 2. — A single track crossing a single track; four derails, eight high signals.

Cost of interlocking plant complete..............	$7,000
Interest on cost at 4 per cent..............	$280
Depreciation per year, 7 per cent..........	490
Cost of maintenance....................	420
Cost of operation per year.................	1,440
Total cost per year..................	$2,630

Saving to be Effected

Trains per day.	Cost per year for stopping trains.	Net saving.*	Time required to pay for installation ($7,000) from saving.	Saving — capitalized at 4 per cent.
16	$2,630	.....	......	......
20	3,285	$655	10.7 yrs.	$16,375
25	4,105	1,475	4.75 "	36,875
30	4,930	2,300	3.0 "	57,500
40	6,570	3,940	1.8 "	98,500
50	8,210	5,580	1.25 "	139,500
60	9,855	7,225	1.0 "	180,625

* Cost of stopping, minus $2,630.

Example 3. — A single track crossing a double track; six derails, eight high signals, two dwarfs.

Cost of interlocking plant complete..............	$8,000
Interest on cost at 4 per cent.............	$320
Depreciation per year, 7 per cent..........	560
Cost of maintenance per year.............	840
Cost of operation per year................	1,440
Total cost per year..................	$2,800

The saving would be the same as in Example 1.

Example 4. — A single track crossing a double track, including four station switches; total switches, derails and signals, 26.

Cost of interlocking plant complete..............	$10,500
Interest on cost at 4 per cent.............	$420
Depreciation per year, 7 per cent...........	735
Cost of maintenance per year.............	480
Cost of operation........................	1,440
Total cost per year...................	$3,075

Saving to be Effected

Trains per day.	Cost per year for stopping trains.	Net saving.†	Time required to pay for installation ($10,500) from saving.	Saving — capitalized at 4 per cent.
19	$3,075	.....	......	......
25	4,105	$1,030	11.9 yrs.	$25,750
30	4,930	1,855	5.6 "	46,375
40	6,570	3,495	3.0 "	97,375
50	8,210	5,135	2.0 "	128,375

† Cost of stopping, minus $3,075.

Example 5. — Single-track drawbridge assuming that men are already employed who can operate the signals; two derails, four signals.

Cost of interlocking plant complete..............	$6,000
Interest on cost at 4 per cent.............	$240
Depreciation per year, 7 per cent..........	420
Cost of maintenance per year.............	420
Cost of operation per year (supplies only)..	120
Total cost per year.................	$1,200

Saving to be Effected

Trains per day.	Cost per year for stopping trains.	Net saving.*	Time required to pay for installation ($6,000) from saving.	Saving — capitalized at 4 per cent.
7	$1,200	.....	......	......
10	1,640	$440	14.0 yrs.	$11,000
15	2,465	1,265	5.0 "	31,625
20	3,285	2,085	3.0 "	52,125
25	4,105	2,905	2.0 "	72,625
30	4,930	3,730	1.6 "	93,250

* Cost of stopping, minus $1,200.

While operating officers may from actual observation appreciate the importance of, and the necessity for correcting yard designs or adapting them to meet increased or changed traffic conditions, it is usually desirable to place an actual money value on such changes or improvements. As this is largely guesswork and dependent on so many conditions it is more difficult to approximately estimate than would be any other line of railroad improvement or betterment work. Some comparatively slight changes, in tracks, connections or switches may be made, by which, through reduced interference, cutting out lost motion, or by more direct or fewer switching movements a yard engine may be dispensed with. Estimating the expense of such an engine with its crew, fuel, supplies, etc., at $25 a day of 12 hours, we have a saving of $9,125 a year which, capitalized at 5 per cent., represents $182,500; from which it would appear that any lesser amount could profitably be expended to attain this result.

If, by correcting errors or improving the track lay-out a saving can be effected in the time of the crews of, say, five hours a day in the aggregate (and this, in a large yard, is ordinarily looked upon as a comparatively small matter) there would be saved $2,190 a year; assuming the time of the road

crew to be worth \$1.25 an hour and leaving out the value of the engine or the demand for it. This saving represents the interest on \$43,800.

Again, assuming a yard handling 1000 cars daily and the possibility of saving an hour's time on each car by making certain changes or corrections. This would be equivalent to 41 additional cars in service, which, at \$800 each, are worth to the railroad company \$32,800.

It should not be assumed that an amount for the corrections or additions may profitably be expended merely because it is known that a saving in operation may be effected representing the interest on this amount, unless it is probable that the saving will be continuous. In this character of work the greater part of the money spent is for labor and much of it for material of a nature tending to deteriorate. It is therefore impossible to recover the principal, should the earnings cease.

CHAPTER V

Track Details

Lead, body and other tracks running next alongside of main tracks, and especially passenger main tracks, should be spaced 16 ft., center to center, to give ample space for handling track, bridge, signal and other materials. This provides, too, for room for posts for telegraph, telephone, electric light and signal lines; signal posts, water stand-pipes, mile posts, section posts, whistle posts, etc., without encroaching on the prescribed clearance between them and cars on the adjoining tracks. Tracks running parallel to ladder tracks should be from 15 ft. to 16 ft. apart, center to center, for proper location of switch stands, to enable lights to be readily seen and for men to have room in which to move while throwing switches, giving signals, cutting cars, etc. Frogs on ladders should be of the same angle, assuming the ladder to be a straight one (and this is desirable) when conditions permit it.

A common practice is to have every second, and occasionally every second and third body track, connected by a switch to the preceding track instead of running out of the ladder. Property limitations, physical characteristics, or urgent need for all space available, sometimes compels this arrangement. It should be avoided, when possible, as the better arrangement and compactness of the switches, the unobstructed view from end to end of the ladder and the ease with which the engineman may select his track, read signals and know his route are advantages which may frequently justify a heavy expenditure to secure them. The movement in and through the body tracks is also much safer and more simple as a view alongside from end to end of the train may be had, assuming the body tracks to be located on a tangent, and signals may more readily be transmitted. It may be necessary, at times, to throw one or two switches away from the ladder to make room for scales, a switchman's box, bridge pier or similar structure. In such cases it is simply a question of whether

or not the advantage of such location outweighs the disadvantage of breaking into the uniform alinement of switches on the ladder.

Split switches of good pattern should be used in all yard work; slips should be avoided as far as possible. Three-throw switches should not be used in connection with any work, yard or otherwise. There are places where the only possible solution seems to be a three-throw switch, but it is difficult to conceive of any situation where a little mental energy with a slightly increased construction account will not enable the engineer to substitute something less objectionable. The saving in the operating expenses will soon overbalance the additional outlay of both energy and capital necessary to secure the result. The liability of three-throw switches to get out of order, with the close and constant supervision required, will run up the account considerably. There remains cost of accidents resulting and interference to yard operations by such obstructions, and the vastly greater probability of derailment or other accident due to mistakes by switchmen.

It is sometimes considered, or found desirable to have a yard cut in two by running a ladder across the middle of it, and in such cases it is difficult to argue against the use of the very flexible but expensive slip switches — expensive both in construction and maintenance. Their use enables any movement from any track in the first yard to any track in the second half, lying in line or in advance. The only partial substitute for the slip switch ladder is a double ladder and that does not give the same flexibility of operation. On the other hand it does enable two sets of operations to be conducted without fouling each other, which is an impossibility with the single slip switch ladder. In the double ladder, for instance, a train may be pulling out of the first yard or "doubling" its cars over in or out of two, three or any number of tracks, while an engine is using the second ladder to separate cars in the second yard. Much additional ground space is required for the double ladder which results in a curtailment of the yard capacity. This may in itself prevent the use of the double ladder where the capacity is limited.

On ladders, the switch stands should be a good pattern of ground throw, one that does not offer an obstruction to a man riding on the side step of a freight car or running alongside to uncouple. The lever must lock itself automatically to prevent its flying over when carelessly or hurriedly thrown by the switchman. It should throw "fore and aft" — that is to say, in the direction the track and car runs, instead of crossways or at right angles to the track — to avoid accident. There are many good stands made that fill these requirements. A switch that can be run through without being damaged may be tolerated in a yard, because of the lessened liability to accident and the seriousness of tying up traffic in a busy yard while making repairs to a switch on a ladder track. While it is a subject to be discussed under the head of organization, or discipline, running through a switch should be just as carefully and thoroughly investigated and the discipline applied should be just as rigid as though it were out on the open road at a point where more serious damage could happen. That it was "in the yard," and that the switch was built for just that kind of thing, should not be permitted to figure in the matter at all; otherwise, the disease will certainly spread and the results may be far reaching.

Only solidly coupled switches should be used in main-line work, instead of spring or other connections which permit a switch to be run through without damage. The solid connection destroys the usefulness of the switch after it has been run through and repairs must be made. It "tells its own story"; discipline accompanied by education does the rest. With the spring or joint connection, a switch, after being run through, may be slightly damaged and yet apparently seem all right to the trainmen. If left in this condition it may cause an accident later on. The greatest objection, however, is the possibility of a small obstruction, pebble, chunk of snow or ice, or a bolt or nut falling in between the track rail and the switch rail and holding the points open while the switch lever is permitted to be seated and locked.

Switches in yards and particularly on ladders, and at other important points, should be maintained in good condi-

tion. The track numbers should be painted on the targets for the convenience of the switchmen. It is good practice to assign a set of numbers to each yard. Most roads have a system of numbering trains, tracks, signals, etc., with odd numbers in one direction and even numbers in the other. The general practice seems to be to use odd numbers on west and south-bound trains. A certain set of numbers should be set aside for numbering main tracks and passing or additional running tracks in conformity with the general practice. In a cluster of yards it may be well to start the first series, assuming it to be eastbound on an east and west road, at 10, and on the westbound at 11. If the eastbound yard contains 8 tracks, the numbers would be 10-12-14-16-18-20-22 and 24. The next yard should then start at 30 or possibly 40. This keeps the numbers in a certain series, and at the same time allows for the extension of any yard without disarranging all the numbers. All switches on ladders should be located on the side opposite the frogs. The targets with lamps should be low enough to clear the pole of a poling engine.

Twelve feet, center to center, is about the minimum allowable distance between body tracks, although in some cases necessity compels 11 ft. 6 in. to be used. A distance of 13 ft. or even 13 ft. 6 in. is greatly to be preferred. Where 12 ft. centers are used the maximum frog angle permissible is that of a No. 7 frog. This makes the turnout curve for a stub switch 12 deg. 26 min., and for a split switch 13 deg. A No. 6 frog gives a lead of 17 deg. and is sometimes used. A No. 8 frog giving a turnout curve of about 10 deg. is preferable, as the lighter angle reduces wear on rails, ties, car wheels and journals. It also reduces the liability of accident, especially where the movements are frequent and rapid. One prominent road uses a standard spacing of 13 ft. center to center for body tracks, in connection with No. 9 frogs on the ladders and No. 11 frogs where connection is made with the main tracks. Another trunk line specifies No. 10 frogs for new work, and where available room can be had, while No. 8 is the minimum. In a recently designed classification yard, a "V" ladder controls 36 body tracks on which No. 7 frogs on

a No. 6 angle are used. As the tracks are but 40 cars in length, it will be seen that the movements over the switches and frogs will not be rapid. The Chicago clearing yards use a standard distance between centers of body tracks of 13.3 feet.

Switches thrown by hand have been considered in the foregoing, and we come now to the question of power-thrown switches, or those thrown from a central interlocking point, in connection with freight terminals. Where passenger movements, or even freight-train movements, are involved, an interlocking arrangement of switches is not only desirable, but quite essential. Where the switches of a freight classification yard ladder are involved there is much to be said on both sides of the question. Up to this time, the hand-thrown switches on the ground seem to possess many advantages. From the standpoint of labor troubles the arguments are pretty evenly balanced. When introducing towers and interlocking, men of a high order of skill and intelligence are employed, and with men of this stamp, who have some little sense of responsibility and duty, a sudden, unnecessary, or uncalled-for cessation of work, with a view to embarrassing the employers to the greatest possible extent, is less likely to occur. On the other hand switches are usually manned by one-armed men, who have been injured in the road's service while in the discharge of their duties, for whom it is a matter of policy and moral obligation to provide employment. The switch tender on the ground may read the chalked number on the rear end of cars of each "cut," in summit or pole switching, and know what to "line-up" for the next "cut." Movements can be made closer as the switch-tender does not wait for a car to pass the clearance point before throwing the switch for the next movement. In this way much time is saved as against the electric systems which compel complete clearance before the next switch can be operated.

In places where there is much snow the hand switch has a decided advantage. It requires an army of men to keep an interlocking plant in operation during a driving sleet or snow storm, because there are so many parts in the switches, such as frogs, locks, rods, detector bars, signals and their connec-

tions, and every part must be kept open for movement to enable any switch to be used. An experiment was recently tried on the N. Y., N. H. & H. at Providence, R. I., which was successful in opening up switches, movable frogs, etc. An engine was equipped with two 9½-in. Westinghouse pumps, two reservoirs with a capacity of 52,000 cu. in., and a line of hose 75 ft. long, and ⅜ in. inside diameter. The opening at the end of the hose was of the same size. An engine crew and four or five men with this arrangement could reach four or five tracks on either side of the engine. On the morning of January 9, 1906, with four or five inches of snow, a test was made and a complete set of double slips was blown out in 4½ minutes. The pressure fell to 70 pounds but was readily maintained at from 70 to 75 pounds. The engine was again tried in four or five inches of snow a few days later with equally satisfactory results. It would make little difference if the depth of snow was four or five times as great. It is, of course, necessary to load up and haul away the snow, but the object is to get the interlocking plant in operation quickly, and this it accomplishes, doing the work of from 100 to 150 men. As it is difficult, if not impossible, to get that number of men out in less than four or five hours during the night, while an engine and crew can be got out in a few minutes, the advantage is apparent. It is the intention to double or treble the reservoir capacity on this engine and add one or more lines of hose. Nozzles with contracted openings will also be attached to the end of the hose with valves, to enable the men handling the hose to shut off the air quickly when not in use, thereby enabling pressure to be maintained.

Switch-tenders can do much towards keeping hand-thrown switches open. Their most important work is to keep the points open. When one switch is open that switch may be used independently of all others, and one switch snowed up does not interfere with another. There is considerably less wear and tear on hand-thrown switches. Their first cost is low and maintenance charges are light. Repairs are readily and quickly made, and in case of a derailment there is usually little interference with other switches and tracks. Many im-

provements are being made in the application of electric power to throwing switches and, doubtless, some improved system may be looked for which will meet entirely, or to a great extent, the objections cited. All things considered, the plan of throwing switches from a tower or central point, by direct lever movements, not interlocked, is the one that seems most practical and economical for classification yard ladders. This view is taken with the knowledge that this method permits fouling of cars, and that special arrangements must be made for advising the switch-thrower of the position of cars during night, foggy weather, snow and rain storms.

In some terminals complete systems of centrally operated switches are installed. The Altoona yard of the Pennsylvania was perhaps the first to install and operate power-thrown switches controlled from a central point. During many years' service this system has worked with ease, reliability and rapidity. The power is compressed air actuated by electricity. The operator in the tower controls the switches by push buttons and when one is thrown an indicator shows when the car sent to that particular track has cleared the switch so that it can be closed again. The use of an advance " cut report " received from the conductor of each train to be classified, and of which a number of copies are made and a copy placed in the hands of each employee engaged in breaking up the trains, including the tower man, enables the operator to set up the proper route for each car without receiving any verbal directions or consulting switching signals. The admission of air by electrically-controlled valves to the cylinder directly throws the points of the switch. It is the regular electro-pneumatic switch movement, without the lock cylinder and magnet. There is no locking movement. In the cabin there are two rows of push-buttons, an upper and a lower one, and there are two buttons for each switch. Each button in the upper row closes its switch, and the button below it opens the switch. The ladder and tracks leading from it are divided by insulated joints into blocks embracing each turnout, and one of the point rails of each switch is insulated from the main rail. An indicator, in circuit with the insulated rails of the switch and

turnout, is located on the operating board just above the set of buttons for throwing the switch. When the track is clear the indicator shows white, and when a car is in the limits of the circuit and in advance of the clearance point, or the switch has not completed its throw, the indicator shows red. A record of 133 cars switched in an hour is claimed, and an average performance of 95 cars can readily be maintained. The air pressure is 60 lbs., and the switch farthest distant from the tower is 1500 ft. away.

In the new clearing yards near Chicago, out of a total of some 450 switches, 120 along the ladder of the classification tracks are operated by electro-pneumatic cylinders. These are built on substantially the same plan as those at Altoona, the central or lock magnet being omitted. The tower has 10 push-button machines, each machine controlling 12 switches. Indicators similar to those at Altoona are used.

At Perth Amboy the Lehigh Valley has for many years operated switches on its coal docks by direct hand-power lever machines, not interlocked. These have given very satisfactory service. The switches are not far distant from the tower and the operator can readily follow the movements of cars with his eye. The electric lighting is ample for the men unloading coal, but work at night is only done in emergencies. The system is simple and there is, therefore, little likelihood of its getting out of order.

There are places where switches may regularly and intentionally be run through with good operating results. Where movements inside of a yard or its adjuncts and away from the main tracks are normal, spring switches may be used in such a manner as to permit their being run through in one direction regularly. This refers to points where all movements are made over the same track and switches in the same direction. On electric roads this is usually done at passing sidings where each car regularly turns to the right (or left) and avoids the delay of having some one throw the switch. For engine movements between engine-houses and coaling plants, ash tracks, etc., this method can frequently be applied with a saving in time for engines and men and a saving in

wages for switch-tenders. The author rearranged a set of switches at a large locomotive coaling plant and ash track, and by the introduction of four or five spring switches at points where they were usually kept in one position, at a total cost of not exceeding $300, was able to dispense with four switch-tenders — two day and two night — saving in wages alone $2,160 a year, besides moving locomotives more rapidly.

The proper lighting of yards facilitates switching and prevents pilfering of cars. Arc lights on poles not too high, set in such a position as to prevent so far as practicable the casting of shadows, are the most satisfactory. It is particularly important that the summit or pole engine leads and the classification ladder tracks be well lighted. Care should be exercised to avoid placing arc lights in positions where they may obscure or confuse signal lights. When lights are badly located they cause patches of bright light and moving shadows of deep blackness, intensified by contrast. There is more liability to confusion and accident under such conditions than there would be in uniform darkness to which the men's eyes become more or less accustomed.

The yardmaster's offices should be located in the most central point available and in a building two or three stories high, to enable him to get a fairly good general view of his yards. Separately, or in connection with the yardmaster's building, rooms should be provided for yard men to eat their lunches, and a sufficient number of lockers, with wire-screened doors for ventilation, to assign one to each employee, so that he can change his clothes before reporting for duty and after serving his turn. Buildings of a suitable character, and at the most convenient points, should be provided for car inspectors, repairers and for their materials. One of the best investments to be made is a good and well-kept bunk house for road crews. This should be located at a point where men can be called quickly, as needed, but where it is also sufficiently quiet for them to obtain rest. The cost of building and maintaining a house of this kind is comparatively small, and the returns in better service obtained from men who have actually rested and are in condition to perform their duties satisfactorily can hardly

be overestimated. It also keeps them away from their cabooses which, for many reasons, are not desirable bunk houses while lying around yards, and from the usual accompaniment of the cheap boarding-house, the bar-room attachment. A day and night lunch room, near the bunk room, is desirable and can usually be made self-sustaining, but no attempt should be made to make more than running expenses.

CHAPTER VI

Ash Tracks

A 100-ton freight engine, burning anthracite and bituminous coal mixed, or straight anthracite will, after an average run with its full tonnage rating, contain in its hoppers from 1½ to 2 cu. yds. of ashes, clinkers, etc. An engine of the same size burning bituminous coal will make from 60 to 70 per cent. of that amount and will be very much easier to clean, as the ashes are lighter and will run out more readily. As there is perhaps no engine terminal handling but one class or type of engines, an average may generally be figured on for the total number of engines at anywhere between the 50-ton and the 100-ton engine, and this will give an average weight for all engines of between 75 and 90 tons each; it being assumed that the heavier engines predominate. At a plant handling from 75 engines, minimum, to 125, maximum, daily, or say, 100 engines a day throughout the year, from 100 to 125 cu. yds. of ashes will be made and have to be cared for on an anthracite road, and probably 80 to 100 cu. yds. on a bituminous road. This quantity will fill six to seven, or five to six cars, respectively. It is assumed that old, light capacity, low-side coal cars are used, and that they are usually not very fully loaded. Cars standing opposite points on the ash tracks where not so many fires are cleaned will get away somewhat lightly loaded.

The fire of an engine burning bituminous coal may be cleaned, under favorable conditions, in from 10 to 15 minutes, running up to 30 minutes for the large engines. An engine burning a mixture of anthracite and bituminous or straight anthracite will require 20 minutes to clean the fire, if it is one of the smaller engines, and 30 to 40 minutes for a larger engine. There is hardly any limit to the time that may be consumed in freezing weather when the engine has been run through snow. Where no special arrangements are provided, it may take, and has taken, three or four men, in extreme

cases as much as four hours to get an engine ready. With the assistance of steam pipes or furnaces to thaw out the hopper slides and the ashes in the hoppers it may run up to one and a half and two hours. When engines leak in their fire-boxes the difficulty is increased. Leaky fire-boxes and flues are among the unfavorable conditions which accompany and aggravate the already existing unfavorable combination of cold and stormy weather and increased demand for motive power. Men will not and can not do the same amount of work when the thermometer is at or below zero and accompanied by a high wind and perhaps snow.

The kind of ash track to be built depends on:

1. Number, kind and size of engines to be handled.
2. Kind of coal used.
3. Weather conditions when the maximum number of engines must be handled.
4. Property limitations.
5. Physical characteristics.
6. Distance ashes are moved.
7. Amount of appropriation available.

Where the number of engines to be handled is small, a cheap arrangement or even no arrangement beyond a spare track on level ground may be used and prove an economical one. An average handling of 70 or more engines a day will enable quite a saving to be effected, if sufficient money is spent in constructing a good ash track in the first place to reduce the cost of handling afterward.

The author planned an ash-handling plant for a heavy terminal where a structure of considerable height, and necessarily of fire-proof construction, enables engines to be run thereon and the ashes dumped, vertically, into empty metallic-body cars standing on an ash-car track directly underneath. This necessitates a span or opening through which the cars may be run under the track on which the engines stand, and preferably an entrance at each end, enabling the empty cars to be shoved in from one end and the loaded cars taken out at the other. This handling may be greatly simplified by using gravity; the empty car-track being on a grade sufficiently heavy to permit the cars to be dropped into position and the loads dropped out of the way. If a gravity empty-car track is not

put in, other cars must be used to reach those to be taken out. The clearance on the low track, as a matter of course, cannot be made sufficient to permit an engine to go under the high track. This plan may seem expensive, but any one who knows what the actual cost of handling ash plants is will not hesitate to recommend a comparatively large amount to enable the handling of engines afterwards in an economical manner, and quickly when needed.

Unfortunately, the " bill of expense " for handling ashes seldom, if ever, tells the whole story and consequently railroad managers continue to permit the heavy leaks to continue. If the maintenance of way department uses or can use the ashes, the expense of loading and unloading is shifted to it. It may, then, be charged under one head or another, according to the views or intelligence of the section or work-train foreman, or the extent to which expenses may be watched in some one particular direction and neglected in another.

There is always a " hobby " somewhere in charging expenses. An instance is recalled where a general officer in charge of the transportation department peremptorily declined to permit the maintenance of way department to use any more old style hopper-bottom coal cars for handling ashes. It became necessary, therefore, to shovel out of solid-bottom cars at great cost. The hopper-bottoms could be seen in the lumber trade and in other business for which solid-bottom cars were suitable or side-tracked awaiting business that might be offered " some day." Somebody paid the bill. This is only one of many instances, in actual practice, where the cheap plan costs the most, or where short-sighted operating managers, while ostensibly guarding the railroad interests closely, are in reality causing the biggest kind of leaks.

The author cannot recall an ash track of the " overhead " type in actual use, but is unable to see a real objection to it. All arguments as to expense may be met. No men would be needed to transfer the ashes to the cars, beyond the regular hostlers and helpers, or " fire-cleaners." The best plan of ash tracks in use necessitates the employment of two men to shovel, day and night, to take care of 60 or 80 or more engines.

At $1.25 a day, which is a very low rate of wages for this kind of work, an expense of $5 a day, for labor is necessary which amounts to $1,825 a year. Capitalizing this at 5 per cent. represents a principal of $36,500. Allowing for deterioration of the plant, etc., it would seem safe to spend $20,000 over and above the amount necessary for any other good type of ash track.

It will be urged that this kind of a lay-out necessitates the use of a special construction of metallic car. Admitting that old cars cannot be used by lining their bodies inside with iron from worn-out tenders, and that not even the trucks of dismantled car-bodies can be used, and that it is necessary to purchase outright new metallic body cars to be assigned to this work, the difference between the value of the old wooden cars ordinarily used and the new cars is the extreme amount to be charged against the new plant. This leaves out of consideration the loss due to the wooden bodies burning out by hot ashes, which frequently occurs. Assuming six cars to be needed for a day's loading — 24 hours — it will require 18 cars. If the unloading point is close at hand 12 cars, or two shifts, will answer. This may, however, require special engine service and prevent utilizing the ashes at the points where most needed. It is better to figure on three shifts, or 18 cars, of which one shift would be at the ash track loading; one on the way out in a local freight train being unloaded and the other on the way back empty. Taking the cost of new cars of light capacity and small bodies at $800 each and the value of the old cars at $400 each, an expense of $400 per car or a total of $7,200 is properly chargeable against the overhead type of ash track as against the side-loading method. The metallic ash car assigned to ash-track work and arranged to dump readily at either the side or bottom is a good investment for any point where many engines are handled. With the metal self-unloading cars, the regular train crew can dump the cars, where desired, provided the section men level them off. If side dumps are used even that provision is unnecessary. With the ordinary car, a work train is needed or at best a section gang for say, half a day. The time of a foreman and six laborers,

half a day at $4.50, amounts to $1,865 a year, and this represents the interest on $37,300. This estimate is made without taking into account the greater disparity between the two methods in cold and stormy weather.

An excellent arrangement for an ash track at points handling heavy business is that of an engine track alongside of and at sufficient height above an empty car track to enable a slope, or series of side chutes, to be used in such a manner as to carry the ashes directly into the cars. The assistance of a stream of water, or raking where the ashes would stop and clog would be all the aid needed to load them, aside from some "trimming" of the cars. The incline, or chutes, should have an overhang at the lower end to carry the ashes well over and into the cars. In this as in the preceding plan, a platform on each side of the engine track and at about the level of the rail is necessary for the cleaners to stand on while working on the hoppers.

A good plan and one in very general use, is similar to the last with the exception of the incline arrangement. The floor of the ash track, level or slightly inclined, of masonry construction, is a little higher than the top of the car standing on the depressed track alongside to enable a hinged metal apron to be thrown across from the ash-track floor and rest on the top of the side of the car. The engine track rails are carried on cast-iron columns about 22 or 24 in. high, placed about 36 in. apart, under each rail. In some plans the rail on the side away from the depressed track is carried on masonry. The track may be made any desired length. It should preferably be long enough to give room on the depressed track for a sufficient number of cars to take care of 24 hours' output of ashes. Where the track is shorter more switching service becomes necessary. If the location permits, the depressed car track should be on a descending grade enabling the loaded cars to be dropped away and empty cars placed without the use of a yard engine.

From these suggestions, cheaper and more simple plants of somewhat similar types may be built for less important terminals. The system of columns described in the foregoing is

frequently used without elevating the engine track beyond such elevation as is secured in the height of the columns and without depressing the empty-car track alongside. This necessitates shoveling and lifting all the ashes loaded and the removal of engines from the ash track or a part of it while shoveling ashes out.

Longitudinal stringers supporting the rails, with a slight depression between, the whole covered with fire-clay, make a cheap and efficient ash track to care for a small number of engines.

Where steam, compressed air or electric power is at hand, a conveyor plant may be successfully operated. This takes the ashes from the bottom of the pit and deposits them in an elevated hopper-bottom bin placed over a loading track. The ashes are discharged into cars by gravity. In connection with power-operated coaling plants this arrangement is to be recommended.

One method largely in use on one trunk line is that of a pit under the engines containing ash buckets which are lifted out by a crane or a compressed-air cylinder moving on a transverse crane. The bucket is carried directly over the empty car, into which it is dumped by tripping the hinged bottom. In some cases the buckets have small wheels under them running on a small track in the bottom of the pit. The bucket may then be readily run from the point where it received the ashes to the crane for dumping and from the crane, empty, to the point where the engine is to empty its "hoppers."

One cinder conveyor for an ash track consists of an iron car running upon an incline track which enters the ash pit at the side. This incline track extends laterally over a depressed track which is parallel with the pit and 18 ft. distant, center to center. The ash car is hauled up the incline by a cable and compressed-air cylinder, and as it arrives over the depressed track, on which the receiving car stands, its bottom is automatically tripped and the ashes dropped.

Fig. 1 shows an ash-handling plant built for the Baltimore & Ohio. It consists of a steel runway 95 ft. long, supported on steel columns securely braced laterally. On this runway

is a 2½-ton, direct-acting, air-hoist traveling crane of 28-ft. span and a lift of from 12 ft. to 16 ft. It is moved along the runway by means of hand chains and the travel of the trolley on the bridge is accomplished by the same means. The entire structure is designed to handle full loads with a factor of safety of five. The crane, bridge and trolley are fitted with "Northern" cage-type roller bearings and the wheels have machined

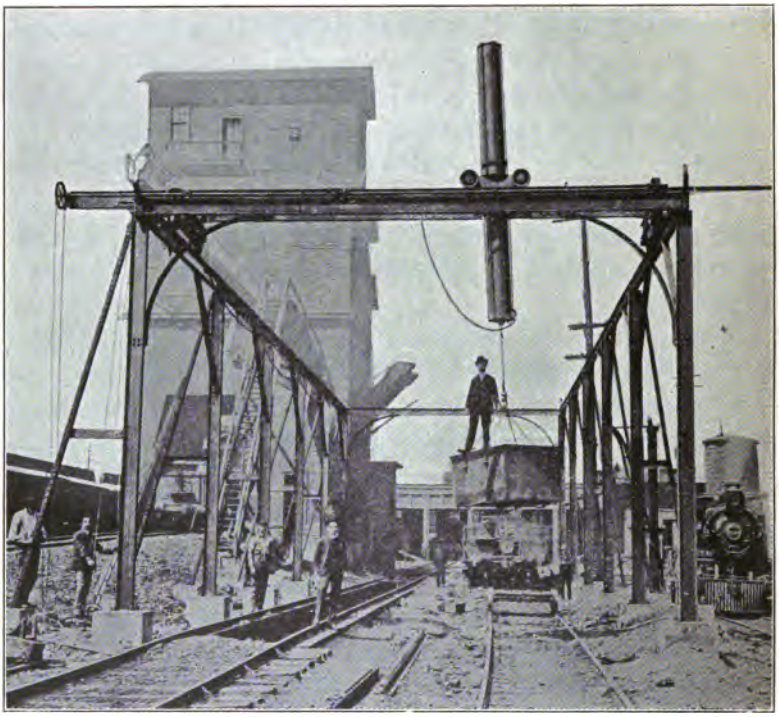


FIG. 1 — Pneumatic Ash-Handling Plant for the Baltimore & Ohio.

treads to make the travel as easy as possible. The traveling chain on the bridge projects beyond the runway, but this chain can be located wherever desired on the bridge. The hoist is direct acting and is mounted on a universal swing bearing on the trolley. The working pressure is 80 lbs., the air being conveyed to the hoist by hose, carried along the runway on small hose trolleys over which it is looped.

In operation the ashes and cinders are dumped from the

locomotive into large metal ash boxes in the ash pit. These boxes are lifted out by the crane and placed on a flat car alongside. The plant is cheap to build and to operate. If preferred the bridge and trolley can be moved by air motors, and for those roads having electric power, electrically-operated plants can be supplied. These are more compact than the pneumatic plants. The builders supply the runway in any span and length required, or the crane can be supplied alone, the buyer supplying the runway.

FIG. 2 — Passenger Ash Tracks at Elkhart, Indiana — L. S. & M. S.

Two sets of ash tracks were put in for each of the recently constructed engine-houses of the L. S. & M. S. at Elkhart, Ind. That for the freight-engine house is 200 ft. long, and has two dumping-tracks in addition to two short pits for yard engines and other engines coming from the house which require their ash pans cleaned. The passenger pits serve two tracks and are 120 ft. long. The design for both is the same, a deeply depressed center track with concrete walls and floor. The dumping-track is supported at the outer rail by a brick wall, and at the inner wall by cast-iron piers. There is a space

between this and the wall of the depressed track for the cleaners to stand. All ashes are handled manually, there being space enough in the pit to clean a large number of engines, after which the force occupies itself by shoveling the cinders into cars on the depressed track. There are several water connections on either side of the pits and also a steam connection for melting out frozen ash pans.

CHAPTER VII

Coaling Plants

The appropriation made for a locomotive coaling-plant should be governed primarily by the number of engines coaled and, secondarily, by the kind of coal used, whether mixing is necessary or not and the amount of coal to be supplied during "rush hours," if there are any. Occasionally the management may decide that it cannot afford to put in all the appliances needed at a large coaling plant. This impression is often due to lack of knowledge as to conditions; otherwise the fact that it cannot afford to do *without* them would be apparent.

As an illustration: A fairly well equipped coaling station in a northern climate was without provision for thawing coal in pockets or in cars to be dumped, although ample boiler capacity for generating steam was close at hand. The division officers were unable, for several years, to obtain authority to spend about $500, to run the necessary steam-pipe lines. A force of five men during the day, and the same number at night, took care of the work during the summer and, when the temperature was not too low, during other seasons. For about three months, each year, 20 to 25 men were used in the daytime and 10 to 15 men at night, picking the coal loose in the cars and pockets. This was probably 20 or 25 men a day more than would have been needed had proper facilities been provided. About $2,500 was wasted each winter because $500 was not spent to save it, and a great part of this amount represented material in the estimates which had a permanent value. The actual loss was far greater since no account was taken of the waste of time to locomotives which could not be coaled promptly.

Another instance: An outlying small terminal coaled from six to eight engines a day. The plant consisted of a flat board platform, at about the height of a car floor. The intention was to shovel the coal from the car to the platform and from the platform to the tender of the engine. This was done,

ostensibly, to release the car. Ordinarily, however, the coal was received in cars of 80,000 lbs. and 100,000 lbs. capacity on which the sides were so high that after a part of the top of the load was shoveled off the coal had to be dumped on the track and then shoveled from the ground to the platform and again to the engine tender. In cold weather the difficulties were increased by snow, rain and freezing. The force employed was not only greatly increased, but frequently the engines could not be coaled in time for their runs. Many times they were run to other coaling stations some distance away where the men in charge already had troubles of their own. The division officers prepared plans for a coaling plant, taking advantage of a favorable contour, at a cost not exceeding $4,500, which would enable all the work to be done with two laborers a day, and not exceeding three during the coldest weather as steam piping was provided for. As the old method required at times from 5 to 15 laborers it was estimated that with the proposed plant a saving in wages of $2,500 annually would be effected, and a still more important saving in the time of engines and disarrangement of schedules. They failed to secure the appropriation.

At a convention of the Association of Railway Superintendents of Bridges and Buildings, the approximate cost of handling fuel coal, by various methods, was given as follows:

	Method of Handling	Cost, cts. per ton
1.	Shoveling from railroad cars to tenders	25
2.	Shoveling from cars to high platforms and again shoveled on to tenders	25 to 50
3.	Crane and bucket from storage platform	35
4.	Shoveling from cars into bins from elevated trestle	10
5.	Dumping from railroad car directly into bins	1½ to 3
6.	Hauling railroad cars by cable up steep incline and dumping directly into bins	3
7.	Dumping from railroad cars into pit and elevating by conveyors	3
8.	The same as above, but elevating by air hoist	5 to 10
9.	Locomotive crane working from stock pile to bins or to tenders	1¾
10.	Dumping through trestle to platform and tramming and dumping into tenders	10 to 15
11.	Dumping into pit in track and elevating skip by switch rope by engine taking coal	5 to 10

It may readily be determined from the foregoing, whether there is sufficient coal handled at any one coaling station to enable the direct saving in handling to earn 10 per cent. on the cost of a modern coaling plant; allowing 5 per cent. for the interest on the money invested and 5 per cent. for depreciation of plant. The company's profit would have to be found outside of this and would be made up, aside from the actual saving over and above 10 per cent. of the actual cost of the plant, in the quicker handling of locomotives, thereby to an extent reducing the number needed to move the traffic; reliability and promptness with which traffic is handled, less deterioration in the value of coal, and prompt release of cars. The actual loss of fuel itself in repeated handlings is an item to be taken into account.

Frequently roads store coal to guard against interruption to traffic due to strikes and other causes. Usually it is dumped on the ground and reloaded; occasionally the reloading is done with steam shovels. Coal exposed to the weather and stored upon the open ground is unfavorably affected and the heating value depreciates quickly. In loading, and especially with steam shovels, a great quantity of stones and natural soil may be picked up.

The kind and size of a coaling plant depends largely on the kind of coal used. With straight bituminous coal the plant may be simple, as provision need only be made for storing one kind of coal and dumping it directly and as it comes, in the tenders of engines. In some instances coal is picked for engines on heavy or fast passenger runs. This only involves setting aside one or more pockets or bins for the purpose, unless the conveyor system is employed. On roads burning anthracite coal the problem is more complicated. Such roads seldom use anthracite exclusively. Nearly all use more or less bituminous coal with the anthracite. They are compelled to use anthracite "lump" on important fast-passenger engines; anthracite "broken" or "egg" on others; and a mixture of bituminous and small size anthracite on freight. Sometimes this is mixed in two or three different proportions for as many types of engines or kinds of service. Others use straight small-

size anthracite, while some may burn straight bituminous. It will be seen that this complicates the coaling, and it requires a well arranged plant to do the work. While it has been attempted to furnish coal mixed in different proportions at "buggy" and "pocket-dump" coaling plants, the mixtures cannot be made with regularity and in uniformly maintained proportions. They will vary considerably, and as the number of engines to be coaled increases, the variation in the proportions will become greater. Where this mixing is not thorough and uniform, the efficiency of the engine's steaming qualities is impaired. This usually happens when the greatest number

FIG. 3 — Lehigh Valley Coaling Station at Plainfield, N. J.

of engines has to be coaled, *i. e.,* when traffic is heaviest and consequently at a time when engines are required to render their most efficient service. A conveyor plant, arranged so that the coal can be fed to the conveyor and the feed adjusted for each kind of coal will give a thorough mixture in practically the proportions desired. With this system ample storage capacity for each kind of coal is necessary.

The belt conveyor system is expensive, but for plants where coal must be mixed it is probably the best. Where mixing is unnecessary the most economical results have been obtained in the ordinary gravity-dump pockets where the loaded

cars are pushed up an incline over the bins, dumped, and from these bins run into the tenders by gravity. The author has handled coal at one of these plants, mixing it in various ways at a cost of a fraction over 3 cents a ton, while a conveyor plant may not load coal on the tenders for less than 5 cents and, more often doubtless at 8 cents to 10 cents unless the amount handled is very large. The conveyor system, however, is the only one making a proper mixing possible.

A typical conveyor plant is that of the Lehigh Valley at South Plainfield, N. J., shown in Fig. 3.

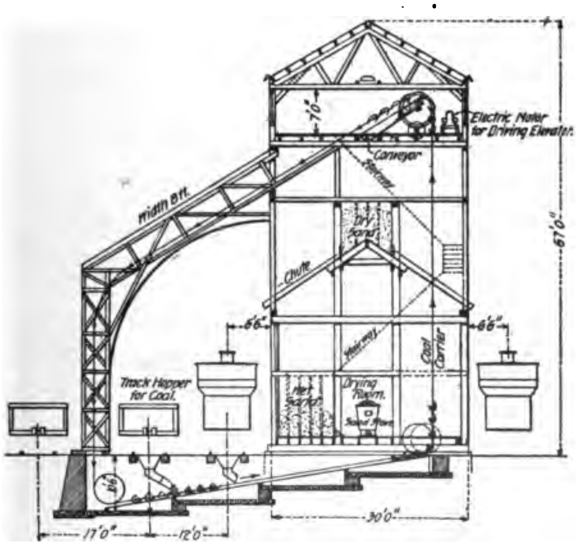


Fig. 4 — Cross-Section of Erie Coaling Plant at Jersey City.

Another similar plant which has been in service for many years is at Jersey City, on the Erie Railroad. It was designed to handle either lump anthracite, " run-of-mine " bituminous or bird's-eye and rice sizes of anthracite using as a binder a small proportion of bituminous. Fig. 4 shows a cross-section and Fig. 5 a skeleton elevation with the general arrangement of conveyors. The carrier is made up of a line of continuous overlapping buckets rigidly secured to two strands of chain, by which the coal is carried along the horizontal run and up the vertical leg without spilling. Above the horizontal run

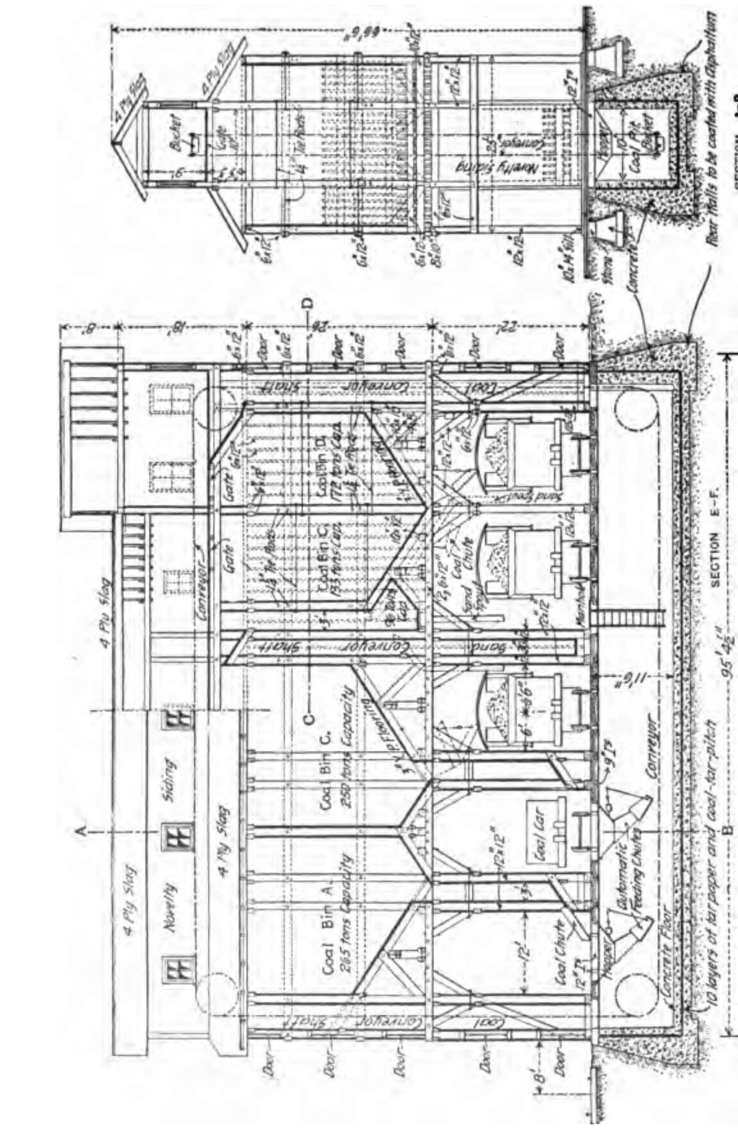


FIG. 7 — Coaling Station of the New York Central at Syracuse, N. Y.

pockets discharge directly into tenders of locomotives. The fourth, containing 265 tons, is held as an emergency supply and discharges through a chute into a conveyor delivering into the bins used for daily supply. The conveying machine is of the "Link-Belt" design, consisting of an endless chain of 36-in. by 26-in. buckets. The elevating capacity is not less than 80 tons of "run-of-mine" bituminous or anthracite coal an hour. The conveyor passes under all tracks through a tunnel, up on one side of the structure, over all storage bins and down on the other side of the building. The two coal-car tracks are provided with large track-hoppers through which coal is automatically fed to the conveyor buckets, these automatic feeders being so designed as to deliver the exact amount of coal to fill each bucket as it passes, without waste.

Provisions have been made for storing 96 tons of dry sand in an overhead pocket from which it is delivered to locomotives on either track through flexible sandspouts. The sand is raised from the track level in steel buckets, on a belt conveyor, the elevating capacity being 20 tons of dry sand an hour. The sand bin is separated from the coal bin by partitions containing 12-in. air spaces, in which are located steam pipe coils to prevent moist air from reaching the dry sand.

Winch heads are provided in each coal track for drilling coal cars. Any water which may accumulate in the conveyor tunnel is removed by a direct-connected electric pump. The entire plant is operated electrically on a direct current of 500 volts, and is lighted throughout by electricity. Eighty locomotives a day take coal and an average of 360 tons is delivered. The cost does not exceed 3½ cents a ton handled. Engines are coaled and take sand at the same time. Both operations are completed, ordinarily, in about a minute.

The coaling station for the Chicago Clearing Yards consists of two 40-ton pockets, with storage bins located under each pocket, having a capacity of about 50 tons each and a receiving pit designed to hold a carload of coal. The coal elevating machinery has an elevating capacity of about 50 tons of coal an hour. It consists of heavy steel buckets

properly secured to a double strand of steel link chain driven by a 10-h.p. electric motor. In operation the coal is dumped from center or side dump cars or shoveled from other cars into the receiving pit, from which it is mechanically elevated into the coal pocket or transferred to the storage bins. From the pockets the coal is delivered by gravity to the locomotives through a gate which is controlled by a man on the tender. Arrangements have also been made to handle the coal mechanically from storage into the coal pockets as required. The

FIG. 8 — C. R. R. of N. J. Coaling Plant at Elizabethport, N. J.

two elevated coal pockets are provided with a weighing device consisting of a dynamometer attached to a gage graduated to indicate the amount of coal in the pockets at any time. The gages are located on the front of the structure, so that the engineman can easily tell the amount of coal taken. The gates controlling the flow of coal from the pockets to the tender are provided with anti-friction rollers which make them easy to operate and positive in action.

A recently completed conveyor plant is the 800-ton coaling station of the Central Railroad of New Jersey at the Elizabethport shops on the Newark Branch, which is shown in Figs. 8 to 11.

The building is of timber and consists of one large coal pocket and a sand pocket. The coal pocket has partitions for the division of the several kinds of coal to be stored, and is provided with eight coal chutes, four on each side of the

FIG. 9 — Conveyor Incline, Elizabethport Coaling Station.

building. These chutes are of a new design, and are operated from the engine tender. There are two sand chutes, one on each side of the sand pocket. Two 24-in. belt conveyors are used. The belts have a 3/16-in. pure rubber cover at their centers. The conveyor "A" is 35 ft. between centers and is driven by a 5-h.p. D. C. Sprague motor. Conveyor "B" is 240 ft. between centers and is driven by a 30-h.p. motor. The coal is discharged from hopper-bottom cars into the track hopper, dropping down over a grizzly to a short conveyor

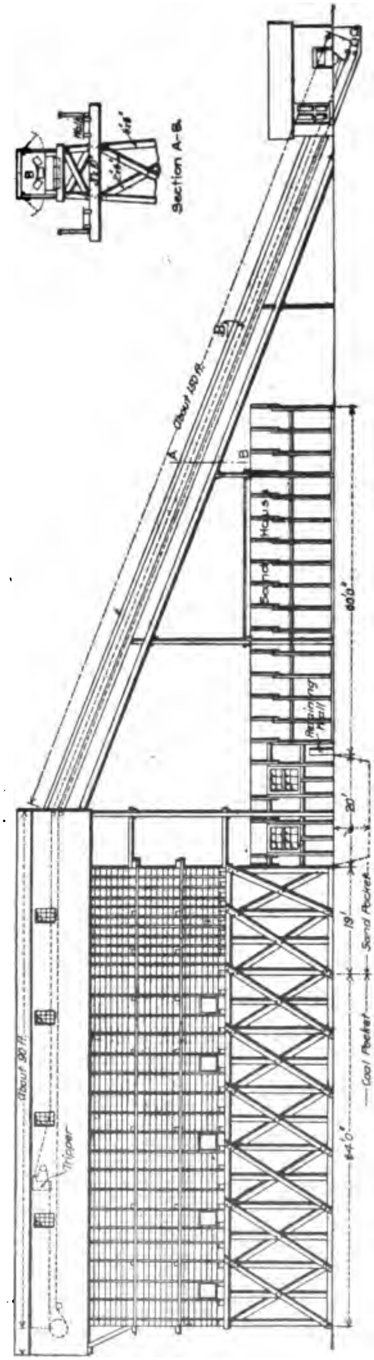


FIG. 10 — Side Elevation of Elizabethport Coaling Plant, C. R. R. of N. J.

"A" which dumps at right angles on the long conveyor "B" which in turn discharges into any part of the coal pocket desired by means of an automatic tripper. Any lumps of coal larger than 8 in. in diameter drop on a shaft at the lower end of the grizzly where they are broken up and fall on the conveyor "A." The troughing, return and guide idlers are of cast-iron and run on hollow, cold-drawn steel tube shafts. These are lubricated by means of patent compression grease-cups mounted on their ends. The tripper is of an automatic reversible type, and can be operated automatically by means of a lever on the side of the tripper and stops placed on the rails, or by hand from either side of the machine, the power

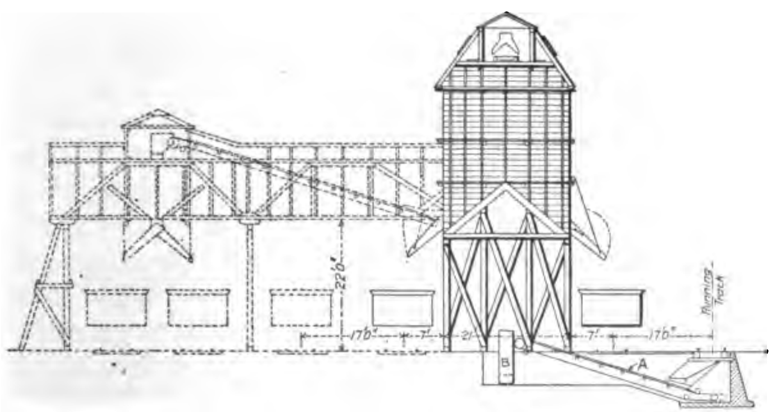


FIG. 11 — Cross-Section of Elizabethport Coaling Plant Showing Proposed Extension.

being taken from the conveyor belt in both cases. The tripper can also be made to operate in a fixed position by throwing out the automatic attachment and clamping the machine to the rails. The carrying portions of the belts are kept clean by means of automatic rotary brushes. The driving pulleys at the conveyor ends have extra high crowns and are secured to the shafts by both keys and set screws, as are also the cast-iron gears. The track hopper and chutes are of yellow pine lined with steel. The sand pocket is lined with Paroid roofing paper and the floor is of 1½-in. planks, doubled, with roofing paper placed between. The plant is electrically driven throughout, and the speed of the conveyor belt is 377 ft. per minute.

For coaling stations of moderate size, handling anywhere from 6 to 30 or 40 engines a day, there is in use on the Pennslyvania Railroad at Elmira, N. Y., Williamsport, Pa. and other places, a method of coaling locomotives that is old but difficult to improve on for the special purpose for which it is intended. Coal is dumped from hopper-bottom cars on a trestle just high enough to give clearance to a small car of metallic construction, running on a narrow-gage track under the trestle; each car having a capacity equivalent to that of the average tender to be coaled, about six tons. At these points the older and smaller engines predominate. When the small car is loaded it is run on a lift which by compressed air power is elevated in a vertical runway to a point where gravity clutches, or chocks, hold it and from which the contents of the car are dumped into the locomotive tender. The small car is built to be dumped by tripping. Compressed air is used because it is usually convenient, but electric or other power may be substituted. At points where no other power is convenient, a very ingenious arrangement consists of a system of pulleys and cables by which the locomotive to be coaled, lifts the platform on which the small loaded dump car has been placed. The locomotive is coupled to the end of a cable at a point on the approach track to the coaling lift. It is then moved forward a sufficient distance to lift the platform with the small loaded coal car to the desired height. At this point the platform is automatically caught and held. The lift, length of cables, etc., are so planned as to bring the tender just opposite the platform in position for coaling, when the platform is elevated sufficiently for that operation. The construction of a plant of this kind is not expensive and the cost of operation small.

The standard form of coaling trestle used on the Pennsylvania Railroad is shown in Fig. 12. Such a plant is cheap to build and to operate.

The conveyor system may be advantageously utilized where available ground space does not permit of an inclined approach for raising the coal in standard gage cars. By using a conveyor, but little more than half the ground space is

needed as for an inclined approach, gravity dump or barrow coaling plant of about the same capacity.

The coaling station of the Lake Shore & Michigan Southern at Elkhart, Ind., was designed and built by the Link Belt Machinery Company, and extends across six tracks. It consists of a steel supporting structure carrying the weighing bins and hoppers and a wooden superstructure. The coal is dumped from hopper-bottom cars into steel hoppers located just south of the chute from which it is loaded by an automatic

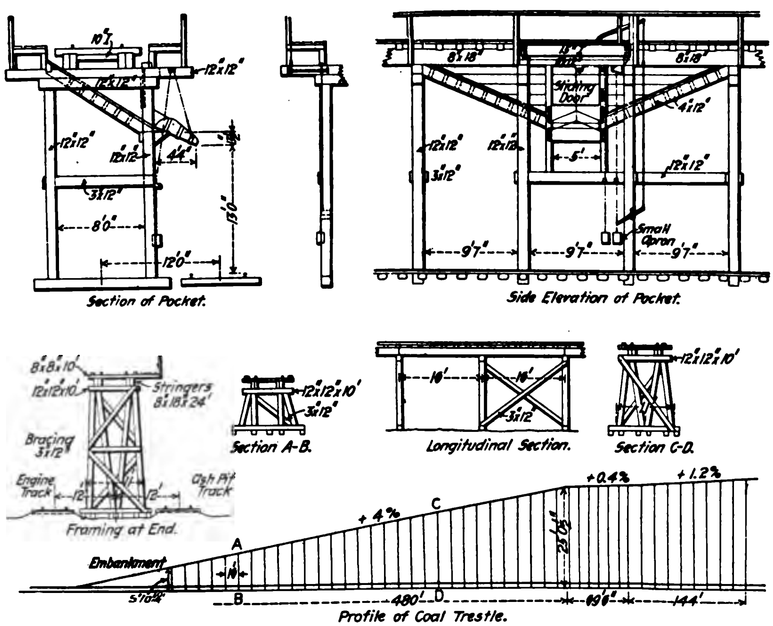


FIG. 12 — Pennsylvania Railroad Standard Coaling Trestle.

loader to the elevator and conveyor buckets which elevate it and carry it across at the top of the chute where it can be discharged into any desired weighing hopper. There are six of the hoppers, each having a capacity of 125 tons. The carrier is driven by a 20-h.p. induction motor, and the loader by a 5-h.p. motor. The sand, after being dried in the building adjoining the coaling station, is elevated by compressed air into a storage bin near the top of the coal chute, from which it is carried by a belt conveyor and discharged into any de-

sired weighing hopper. There is a flexible pipe for connection to the locomotive sand boxes. The five water cranes are located so that water can be obtained from any track passing underneath the coal chute, thus allowing a locomotive to receive coal, sand and water at the same time.

Records of coal dumped, furnished locomotives, etc., should so far as practicable, be kept without imposing much, if any of the clerical work on enginemen, firemen or hostlers. Where these men are required to do much of this kind of accounting it not only takes their minds from more important work but records are inaccurately and unreliably kept. Very few roads are so equipped as to be in a position to keep even a fairly accurate record of coal consumption, and to make an equitable distribution of it. The "adjustments" at the end of the month or other time period are depended on to balance the accounts. An engineman, fireman or hostler cannot be expected to even approximately estimate the amount of coal he leaves in a tender or the amount he finds there when he takes charge of the engine. Where the coal is dumped by gravity into the tender, a "guess" is made, which is usually far from accurate. In the absence of arrangements for weighing or measuring, the discrepancies are great. Where the barrow system is used — a barrow usually containing a ton — the amount may be more closely figured on, but that too is unreliable. The coal is then bought by weight and charged out by volume. Considering all the uncertainties, the most satisfactory system is that requiring the foremen at the coaling plants to keep the records of coal furnished. Enginemen, and others in charge of engines should not be asked to do anything beyond possibly certifying to the coaling plant foreman's ticket as to the amount of coal supplied. While the results in the way of accuracy may not be all that are desired, they will certainly be no less accurate, and the advantage gained, in other directions in relieving road men of desk work on engines, is in favor of making records at the coaling plant.

An investigation of the cost of handling engine coal from the cars to the engine, on different railroads by different systems of coaling appliances, has recently been made, and

the maximum, minimum and average figures are tabulated below:

TABLE I. — ACTUAL COST OF HANDLING COAL FROM THE CARS TO THE ENGINES AT VARIOUS PLANTS

(No allowance for interest and depreciation on first cost.)

Method of coaling.	No. of plants averaged.	Tons of coal handled per diem.		Cost per ton in cents. Minimum.	Maximum.	Average.
By hand from cars........	12	3 to	12	5	14	10
By hand from cars........	5	24	206	12	20	15
By trestle (no repairs)....	5	4	55	5	13	9
By trestle (no repairs)....	7	127	346	2⅔	8	5
By elevator (no repairs)..	3	73	212	3⅓	6¼	5
By belt conveyor (includes repairs)	18	15	1053	2	6¼	4¼

Inasmuch as the cost varied a good deal for the same type of coaling station, when the daily quantities of coal handled differed widely, an estimate of the cost of coaling from different types of stations when of the same capacity, 700 tons per diem, was made, including in the items an allowance for interest and depreciation on first cost, and repairs. The figures are based for the most part on actual cost at stations of each of the types.

TABLE II. — COMPARISON OF VARIOUS TYPES OF COALING STATIONS — ESTIMATED COST OF HANDLING COAL PER TON BASED ON A DAILY CAPACITY OF 700 TONS

(Includes interest, depreciation and repairs.)

Method of coaling.		Cost per ton in cts. When handling 50% of rated capacity.	When handling 125% of rated capacity.
Should use self-clearing cars	Inclined trestle	4.1	2.8
	Holmen bucket elevator	3.9	2.6
	Belt conveyor	4.5	3.0
	Belt cross conveyor	5.2	3.9
All hand shoveling	Steam cylinder car hoist & platform	8¾	7¼
	Car hoist and platform...........	12⅓	10
	Platform and trestle.............	10 to 17	8.5 to 14
	Platform, bucket and hand crane..	11 to 15	9 to 11

In 1885 a committee of the Roadmasters' Association investigated the costs of handling coal by the different methods in use. For handling over platforms of different constructions the maximum was 30 cents a ton and the minimum 11 cents,

with an average of 19.4 cents. For coal chutes the maximum was 9 cents a ton and the minimum 4.5 cents, the average being 7.4 cents. The average saving in favor of the chutes was therefore 12 cents a ton. The time consumed in taking coal from the chutes was one minute, and from other devices 12 minutes — a saving of 11 minutes per engine coaled in favor of the chutes. Where 3,000 tons were handled monthly there was a saving in favor of the chutes of nearly $4,500.

A special arrangement installed on the Pittsburg, Cincinnati, Chicago & St. Louis, at Columbus, Ohio, 20 years ago consisted of a self-contained steam crab crane on a trolley having longitudinal movement over the whole length of an overhead traveling girder spanning three parallel coaling tracks. The girder moved on rails carried on trestle runways 25 or 30 ft. high on each side of the coaling tracks. The coal was shoveled into 2½-ton, drop-bottom buckets sitting on the ground, and they were lifted by the crane and dumped into the tenders. This station was designed to meet certain conditions, one being that the coal was received in flat-bottom gondola, box and stock cars. Also at certain periods of the year a supply of coal had to be kept on hand at the wharf, while at others the coal could be unloaded direct into the buckets. The cost per ton, not including interest on plant, was 8.7 cents. Average time for coaling an engine, 6 minutes.

In 1902, a committee of the American Railway Engineering and Maintenance of Way Association considered carefully the question of coaling stations. A list of the principal factors to be considered in adopting a method, given in that report, is well worth reproducing here, being as follows:

1. The question of location is one of the most important for consideration. This will be governed by the convenience as to the operation of the business of the railroad. At terminals and at junction points it is probable that large coaling plants will be desired; but at intermediate points on the line, coal must be supplied to locomotives hauling freight and passenger trains. The location may determine largely the nature of the plant to be used. Where large quantities of fuel are to be handled with only a limited amount of room for the construction of tracks and buildings, an expensive mechanical plant may be fully justified. At other points where land values are small, a totally different style of plant may be the most economical.

2. The quantity of coal to be handled will also largely influence

the character of the plant to be built. Where but one or two carloads of coal per day are required, it is doubtful whether anything but the simplest plant should be built that is sufficient to permit delivering the coal required in the least possible time. On the other hand, where from 200 to 400 tons per day have to be handled, expensive plants, well-designed machinery and first-class construction will be justified.

3. A third consideration is the cost of operation. This touches upon the labor question, involving the consideration whether steam engineers, machinists and expert mechanics, or crude day labor shall be utilized in connection with the operation of the plant. In some parts of the country, day labor may be had at approximately one-half the rates which are demanded in others. The rate of wages to be paid to the laborer will be an important item.

4. A fourth consideration will be the amount of first cost, and also the cost of repairs and renewals. It is evident that to make a true comparison of the economy of different plants, these items should be reduced to a measure of cents per ton of coal handled, rather than to make a comparison of the gross amounts of actual cost and maintenance.

5. In the same connection, a true comparison will require a consideration of the interest on the cost of the investment, and this also should be reduced to an equivalent value of cents per ton of coal handled.

6. Complicating all of the above is the question of storage. That this is a matter of great importance, and that it usually receives but little consideration, is evident from the amounts which are annually spent in storing coal on coal cars and holding the same on side-tracks at coaling stations, rather than constructing suitable storage bins in which the coal may be kept, thus liberating the cars for commercial business.

7. The kind of coal handled will also influence the decision — whether it be anthracite or bituminous, or both, inasmuch as the appliances which are efficient for one kind may be less so for the others.

8. The facilities which each company has for delivering coal to its coaling plants will tend to make the situation more involved, since coal may be handled either in box cars, gondola cars (with stationary or with movable sides or traps), side-dumping or bottom-dumping cars, and other varieties, each of which will have its own influence on the special modification of plant to be adopted for economy.

CHAPTER VIII

ICING PLANTS

The icing tracks should be located in advance of the classification yards, in such position as to permit of forward movement from the receiving yard, without reversal, to the classification yards. Where the volume of business requiring refrigeration justifies it, and the method of handling is such as to keep it in solid trains, much time may be gained by handling it through a separate set of tracks, and keeping it out of the main classification yards altogether. Care should be taken to avoid locating buildings where they will interfere with future development.

One recent plant, that of the Chicago, Burlington & Quincy at Hannibal, Mo., is shown in Figs. 13 to 17.

This plant was designed to re-ice cars in transit with the least possible delay. The building is divided into three large compartments which, together, have a storage capacity of about 3,000 tons of ice. These separate compartments are arranged so that when taking out ice the circulation of air, caused by the doors being open, is confined to a single compartment and the entire ice supply is not exposed. The building is 164 ft. long and the icing platform is 200 ft. long and 8 ft. wide, making room for icing six cars at a time. At the middle of the platform and on a level with the lower platform is a room, 16 ft. long and half the width of the building, which is used for storing salt. Directly above is a compartment of similar size in which the ice is prepared. The icing room has double doors opening on the upper platform, and also a single door at the rear through which the ice is brought. Ice is now elevated to the level of this room by a windlass, but it is proposed to install a hydraulic hoist. The ice is broken by wooden mauls and loaded in small dump cars. Six ice cars are used, each holding about 1,200 lbs. of ice. After the small cars are loaded they are kept in the icing room until a train arrives, when they are run out on the upper platform and the contents

FIG. 13 — Icing Plant of the C., B. & Q. at Hannibal, Mo.

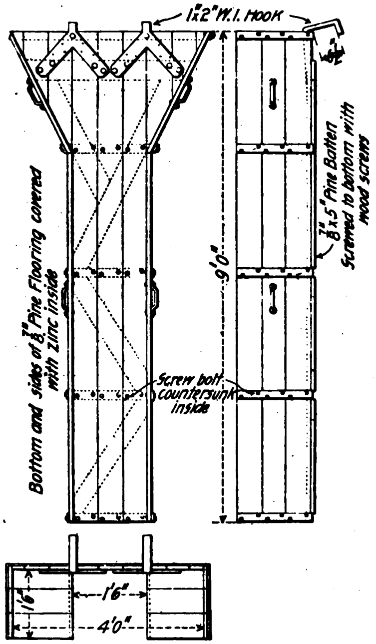


FIG. 14 — Details of Ice Chutes.

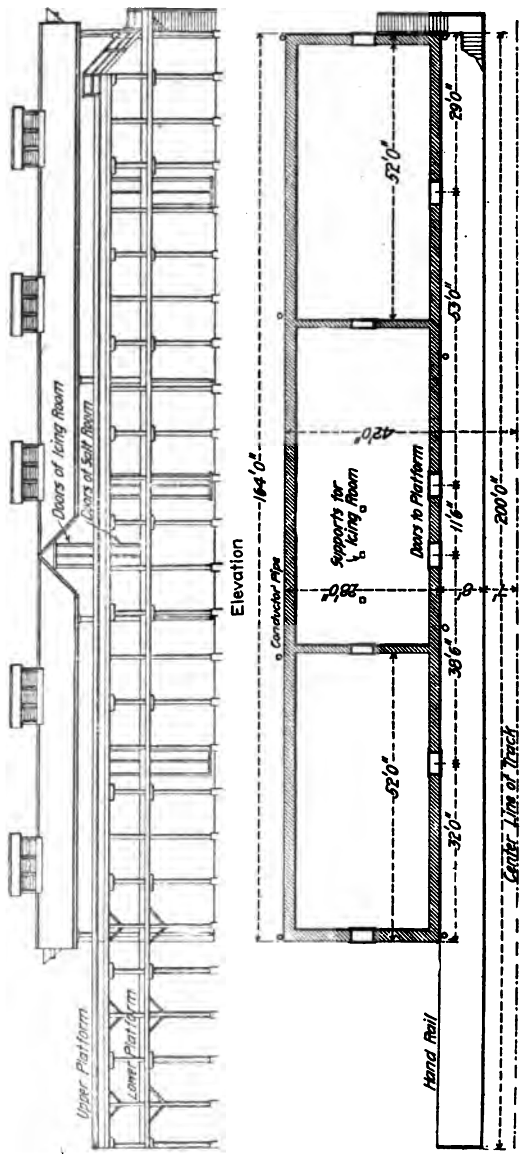
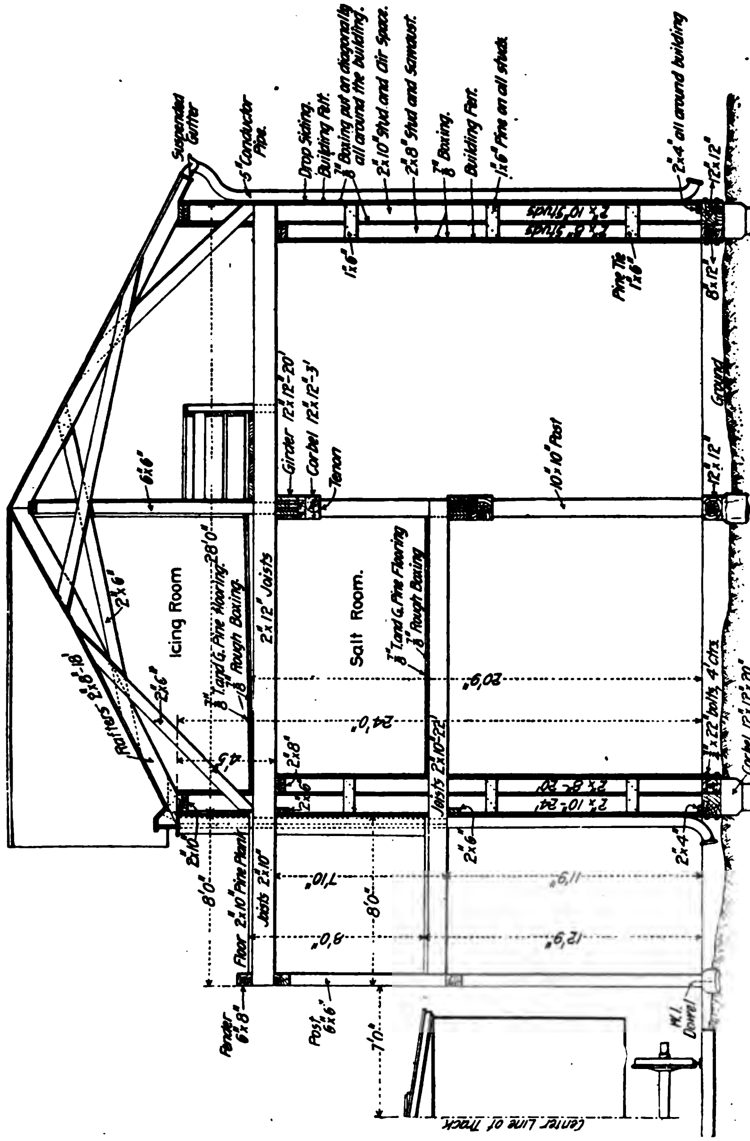


FIG. 15 — Plan and Elevation of C., B. & Q. Icing Plant at Hannibal, Mo.



Section Through Icing Room

FIG. 16 — Cross-Section Through Ice House and Platforms.

dumped directly into the ice-boxes of refrigerator cars through chutes. The salt is mixed with the ice by the attendants at the time the ice is spread in the boxes, and these attendants work on the lower platform and car roofs, which are about the same

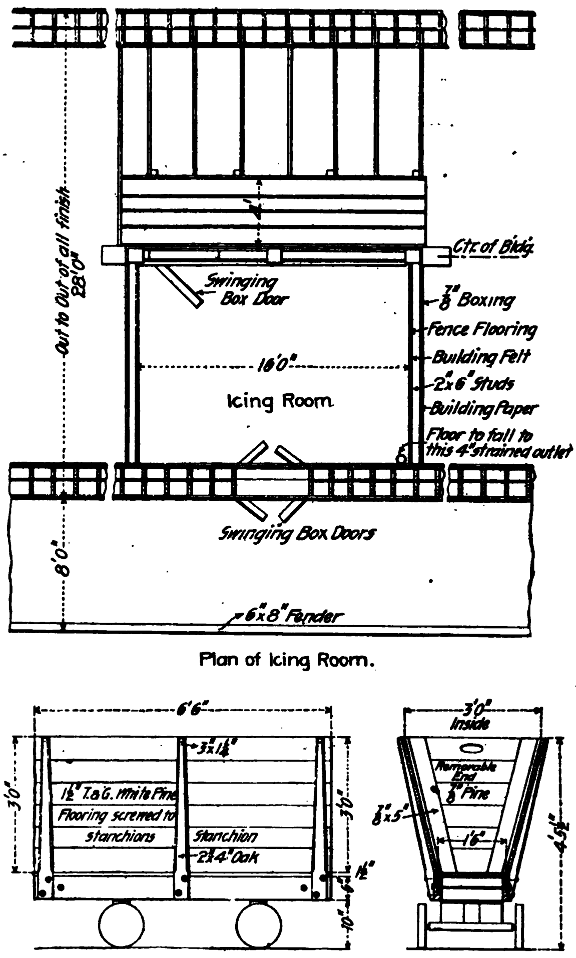


FIG. 17 — Plan of Icing Room and Details of Icing Carts.

height. It will be noted that the salt room opens on the lower platform, so that this work can be done conveniently. In extremely hot weather about 10 per cent. of salt is required for fresh meat shipments. The details of the small ice cars and

chutes are shown in the engravings. Being able to work on six cars at a time, they can be iced quickly and economically. The number of men required about the plant varies with the number of cars to be re-iced, and this business fluctuates so greatly that there is no regularly organized force, but men are used when needed that are differently employed at other times.

Few roads have any systematic method for the preservation of perishable freight while in transit. There is considerable variation in the temperature at which different commodities of a perishable nature are liable to damage, and they may be further affected by their condition when shipped, time in transit, time continually in motion, etc. With the use of the modern car there is no good reason for permitting freight to become frozen. It is only during extreme winter weather that the use of the heater car becomes necessary. If produce has been exposed to low temperature for some time before being placed in a car, it is not in a condition to withstand cold. A car of produce, such as potatoes, will in all probability stand a lower temperature when the car is in motion than when at rest. With the outside temperature at 20 deg. perishable goods may be safely shipped in ordinary freight cars and in refrigerator cars down as low as 10 deg. above zero. It is further claimed that these goods may be safely shipped in refrigerator cars with the temperature nearly 10 deg. below zero, if the car is heated before being loaded and the goods, at the end of the trip, are immediately taken to a warm place without being handled any great distance in a dray. In the best refrigerator cars, perishable goods may be safely handled with the temperature as low as 20 deg. below zero, provided they are not subjected to such cold for more than three or four days at a time; with the ordinary refrigerator cars the most perishable goods are liable to be damaged in zero weather. Before shipping fresh beef, it should be chilled to 36 deg., although 40 deg. will suffice under favorable conditions. It is considered important that the beef be kept at a uniform temperature from the time it is started until it reaches its destination, and the cars should therefore be at the same temperature as the chill rooms. In summer, cars need re-icing

frequently to maintain the proper temperature and no fixed rule can be established as to time or distance between re-icings, this being governed by the outside temperature.

There are some possibilities in the way of heating cars by the use of ice, and the Government Weather Bureau has given the question consideration. A car has been designed that is to use ice with salt, in summer for the protection of perishable goods in transit and the same car is to be iced in winter to prevent freezing. This is on the theory that ice, which is normal at 32 deg. Fahr., absorbs heat at a higher temperature, and imparts heat at a lower temperature. Hence, when it is zero weather outside, the cylinders in a car containing relatively warm ice act as stoves, helping to keep up the temperature inside. Another method for protection against freezing consists in throwing a stream of water on the car when the thermometer is near the zero point. The water freezes and forms a complete coat all over the outside of the car. This prevents the warmer air from coming out of the car and so tends to keep up the temperature inside. This is particularly advantageous in the transportation of bananas, which are quite susceptible to cold. Fruit of this kind is put in paper bags inside of heavy canvas bags and covered with salt hay when the temperature is dangerously low. No theory has, as yet, been suggested to account for the interesting phenomenon that perishable produce, such as fruit and vegetables, will stand a lower temperature when the car is in motion than when it is at rest. The use of paper for protection against cold is increasing and its effectiveness is wonderful. Fruit wrapped in heavy brown paper will endure 15 deg. more cold than without it. Potatoes are sometimes packed in barrels lined with paper, and when the weather is unusually severe the barrels are also covered with paper. Clams and oysters are similarly shipped in paper-lined barrels to keep them from freezing and cars for transporting perishable merchandise are quite commonly lined with paper. There is said to be nothing like it to keep out frost. Eggs shipped in crates with separate pasteboard divisions and covered with a layer of oat chaff will stand a low temperature. It is found that pickled eggs are

injured by cold more quickly than fresh ones. Fruit products in cans or glass must not be shipped when the temperature is below freezing. A well-ventilated dry cellar is the best place to store apples, potatoes and vegetables generally, the temperature being from 30 to 45 deg. Apples are not made unfit for use by freezing, if they are allowed to thaw gradually. Tropical fruits in storage should be kept at from 60 to 70 deg. Mineral waters exposed to a temperature below 30 deg. soon spoil. Beer may be shipped with the outside temperature at 10 deg. if the kegs are packed in hay or sawdust and fresh stable manure. Butter freezes at 15 deg. and when thawed it quickly becomes strong. Milk should never be allowed to freeze. Pork is injured more quickly by high temperature than other meats.

Instructions issued by one road for handling icing plants and icing and re-icing of cars containing perishable freight are as follows:

1. Regular shippers of dressed beef, provisions, etc., will be advised by the Traffic Department that, if they desire cars iced, they must note on their shipping tickets at Chicago or other western points (which will be carried forward on the regular or card manifests), "Ice at ——."

2. No cars containing dressed beef, provisions, or other perishable freight, should be iced at that station unless the waybills or card manifests bear the notation, "Ice at ——," or unless ordered by a proper officer of this Company in case of emergency.

3. Agents at receiving stations and junctions points will wire direct to the agent at —— the number of cars requiring ice at —— that each different beef company has on the various trains leaving their stations. The agent at —— will keep himself advised by wire as to the probable time of arrival of such trains at the icing station.

4. The agent, yardmaster and conductors will be responsible for the prompt placing and handling of refrigerator cars at the icing station, and must be thoroughly familiar with the schedules to be maintained.

5. The agent will see that the foreman of the icing station ices cars without unnecessary delay after they are placed, and will use sufficient ice to protect the lading according to the character of the freight and the service to be performed, making proper allowance for any probable delays in movement and delivery, and care should be taken not to use any unnecessary quantity of ice.

6. A record must be kept by the foreman of the icing station of the estimated weight of ice in the boxes on the arrival of each car at the icing station; also the condition of the waste-pipes, temperature of car, and condition of lading, if the car is not sealed, together with a record of the time of arrival and departure of the car at the icing station.

7. The foreman in charge will be held personally responsible for seeing that the ice already in the tanks of refrigerator cars on arrival at the icing station is properly tamped down with poles before any more ice is put in. Great care should be exercised to see that the waste-pipes are properly rodded and running freely. Before putting ice in the boxes, the ice (either in blocks or crushed as directed) should be thoroughly cleaned. Wooden tamping-sticks only should be used. Do not use hooks or other pointed tools in tamping or shifting ice in the tanks.

8. The foreman at the icing station will accept direct advices from the shippers as to the quantity of salt they want used in icing their cars, as different shippers have different ideas on this subject.

9. With instructions to use salt and no definite instructions as to the amount, spread uniformly on top of ice not less than nine pounds of salt to 100 pounds of ice used.

10. Use coarse rock-salt if obtainable; if not, common barrel salt. Do not use salt at all if instructions on waybills or conductors' tickets bear notation that no salt is to be used.

11. The regular charge for ice, labor and salt is at the rate of $2.50 per net ton for the actual amount of ice put in each car.

12. A complete and accurate report of the weight of ice used for each car must be kept by the foreman; and bills for icing must be rendered monthly by the agent to, and collected through, the comptroller.

13. The agent will give monthly credit for the icing charges to such firms as may be designated from time to time by the comptroller.

14. When refrigerator cars loaded with perishable freight are wrecked, or shopped for repairs, or exceptionally delayed from other causes, the ice-boxes of the car containing the lading should be examined, and, if necessary, re-iced before such cars are forwarded; and if the lading is transferred, the car into which it is transferred should be previously chilled and fully iced, and report made by wire to the division superintendent, comptroller, and the freight traffic manager as called for by general manager's circular.

15. When cars are iced for firms other than regular shippers to whom credit is authorized by the comptroller, the agent at —— will expense upon the delivering agent for the cost of re-icing, waybill to accompany the car, and amount to be collected from consignee or connecting road upon delivery.

The same road issued the following instructions to govern those interested in transferring dressed beef in case of accident:

First, wire the division superintendent, giving the initials and numbers of the cars damaged, and state whether the contents of all the cars will have to be transferred, and how many refrigerator cars are required for that purpose.

Second, wire the freight traffic manager, giving the same information, and, in addition, the name of the shipper, the point of origin and the destination of the property.

Refrigerator cars in good order and WELL ICED must be secured and taken to the place of wreck.

It must be remembered that fresh beef when exposed to the air,

or if transferred into cars that have not been previously cleaned and iced, will spoil.

Great care should be taken to KEEP THE BEEF OUT OF THE DIRT, and when handled from one place to another MUST BE CARRIED, and not thrown.

Boxed meats are usually loaded in the center of the car, and are to be taken out and placed aside until the other car is ready to receive them.

Hang the HIND-QUARTERS at one end of the car, on SHORT HOOKS, shanks up, and closely together, putting insides to insides and skin sides to skin sides, etc.

Hang the FORE-QUARTERS at the other end of car, on LONG TWO-PRONGED HOOKS, neck end down, and see that hooks are placed in the same holes as before. Hang the fore-quarters same as the hinds; insides to insides, etc.

When no hooks are available, small hide or other rope may be used, being particular to string the beef through same holes that the hooks were in.

Dressed calves, sheep and hogs should also be hung up, and may be put in any unoccupied place.

THROW THE LIVERS AWAY, as they will spoil after exposure to the air.

REMOVE MEAT HOOK AND RACK EQUIPMENT from disabled car along with the beef.

Advise the division superintendent AND the freight traffic manager by wire, numbers of the cars into which transfer is made, and the time they are forwarded.

One refrigerator line has issued the following instructions and suggestions as to the proper manner of re-icing their cars:

1. ICE. — All that is to be used in icing cars of this line must be washed clean; it must be free from hay, straw or sawdust. *This is very important.*

2. BREAKING ICE. — Before the ice is put into the tanks or receptacles, it must be broken up in small pieces — the largest piece to be not larger than a man's fist. The ice *must not* be broken on the roofs of cars.

3. ICING. — Before putting new ice in the tanks of cars, the old ice in them must be tamped down solid, using a wooden tamper to tamp the ice — a piece of 2 x 4 will answer. Great care should be taken to carefully tamp ice in tanks, as the salt used has the effect of honeycombing the ice, giving tanks the appearance of fullness, which in fact does not exist, and there is usually room for more ice after using tamp. Do not use ice hooks or other pointed tools for tamping or shifting ice, after it has been put in the tanks, as by the use of such tools, holes are liable to be punched through the tanks, allowing water to get into the car, which would damage the contents of car.

4. SALT. — Cars should be iced with not less than 12 pounds of salt to every hundred pounds of ice used to re-ice car. When car is opened for icing, about one-third (1/3) of the salt should be applied on top of the old ice before the ice is tamped down, distributing the balance of the salt evenly on top of the ice in the tanks after the tanks have been filled. A sharp wooden tamper should then be used

to work the salt well into the ice before the covers are replaced. Coarse or rock-salt should be used if possible to obtain; if not, use common barrel salt. The application of salt in the proportion as above stated in icing cars of this line is very ***important*** and must not be disregarded, for without salt in icing our cars the desired refrigeration cannot be obtained.

5. Salt. — Always should be used as per above instructions in icing shipments made in our cars, unless shipments are billed and carded to be re-iced with a greater or less per cent. of salt, in which case please follow the instructions on bills or cards, and if shipments are billed and carded, "Re-ice without salt," please be governed accordingly.

6. Covers.—Fill the ice tanks as full as possible, being careful to see that the tank covers are properly replaced before cars are allowed to go forward.

CHAPTER IX

Switching Methods

1. *"Link and Pin"* or *"Tail"* Switching. — This is the oldest known method, and consists in coupling to one end of a string of cars, pulling back and pushing forward, heading the cars into such tracks as may be desired. It is slow, expensive in operation and damaging to cars, increasing with the heavier power in use. In many yards, and particularly in cities or other points where a crowded condition exists, it is the only practicable method of handling. Smaller yards, such as freight houses and transfer yards, local delivery and coal yards, etc., are invariably operated in this manner. In larger terminals, it should be done away with as rapidly as possible. Among other bad features it has the objectionable one of moving cars in the reverse direction. In most cases many reverse movements of a car are made before it reaches its proper track in the separation, classification or storage yard.

2. *Poling.* — This method is so far in advance of tail switching, is so elastic in the matter of possible expansion, and has made such an exceptionally good record in passing cars through division, junction and tide-water terminals, with a minimum of delay and of damage that it is generally recognized as one of the best methods of switching and separating cars.

3. *Summit* or *"Hump."* — By this method cars are pushed over a summit, usually an artificial one, ranging anywhere from 6 ft. to 15 ft. in height, and after uncoupling are run down from the "hump" or summit by gravity. Some remarkable work has been done and records made, recently, in hump yards. The plan has many points to commend it for adoption in any terminal.

4. *Gravity.* — In a terminal of this character the yards are located on a grade sufficiently steep to start a car when the brakes are released. There is consequently little need for a yard engine except to start or feed the cars, and when low

temperature or other weather conditions are such as to prevent a car from running. Gravity yards are unusual because economical construction requires favoring topography at a precise spot.

CHAPTER X

Pole Switching

This requires an additional track for the ram or poling engine alongside the entrance leading to the yard. In some cases yards are arranged to enable the poling to be done directly from the receiving yard into the separating or classification yard. The switch engine has a pole attached to the pilot beam which is so manipulated as to come in contact with the poling pocket on the rear corner of the last car in the " cut " to be started. Usually a car is built called a ram car, equipped with four poles, two on each side; one of which works forward and the other to the rear. This car is also used for the men to ride on, and is probably a safer method of working than to use a pole directly from the engine's pilot beam, by which the man guiding it can easily get caught if it should miss its mark or slip from its hold on the car. Frequently two " cuts " are started, a double cut, by placing the pole behind the last car in the first cut and then uncoupling between the two cuts after the cars are under fairly good headway, after which additional momentum is, of course, given the first cut in order to give sufficient room between that and the following cut to enable proper throwing of switches. On a level road this method is very hard on equipment. The cars require a heavy start and engines are rapidly worn out on account of heavy, quick starting and reversing. These conditions are aggravated during cold weather when cars run harder. In such yards it is desirable and usually necessary to continue the poling track along the ladder. In every switching yard, a descending grade running with the traffic movement is of great advantage, and it is especially desirable in a poling yard. Without an assisting grade, a poling yard handling a heavy business requires an engine to push trains being switched to the front, but when the grade is favorable, the train may be started and, under regulation of brakes, continue to drop forward at uniform speed as rapidly as the

poling engine can work up the cuts. A descending grade of 0.4 per cent. is valuable, but as heavy as 0.8 per cent. or even 1.0 per cent. may be used to good advantage and during winter will be none too steep. In larger poling yards it is found to be economical to provide an additional track for an engine to work on in running down into the separating yard and bringing back the car riders, although usually the poling engine may be used to make an occasional run, when car riders are not returning fast enough. In one large poling yard, a car propelled by electricity by an overhead trolley, running on a separate track, is used to return the car riders. This company has an electric plant for other purposes, and illuminates the switch lamps by small incandescent electric lights.

To handle a heavy business it is desirable that immediately on the arrival of a train from the road, the switching of that train be started. To this end it is essential that the engineman, cutter, switchman and conductor of the poling engine have a copy of an advance telegraphic report (called a "consist," "make up," or "destination" report) informing them where each cut is to be made in order to avoid waiting for the car way-bills. Such a report can be sent in brief and satisfactory form by a telegraphic cipher code. One of the best forms consists of a number of lines, 1, 2, 3, etc., up to 50, 80 or the number representing the highest possible number of cars in any train. By using abbreviations for destinations, this may be telegraphed very quickly. For instance in a train of 30 cars, the first 10 for the Baltimore division, next 10 for the Chicago division and the last 10 for the St. Louis division, it would be telegraphed thus: — 1-B 11-C 21-S, assuming B, C and S to be the abbreviations or calls for the divisions named. The car cutter knows that the first 10 cars go to the track for the Baltimore division and that the first coupling to be separated is that between the tenth and eleventh cars. This may be enlarged on, to any extent desired by the operating men, by having the initials and numbers of the cars telegraphed, the contents given, etc.

In a paper read before the New York Railroad Club Mr. C. L. Bardo presented the following interesting figures of

an actual series of tests made by him to demonstrate the superiority of one switching method over the others, having selected for each test a train of 60 cars with 50 cuts:

	TAIL	POLE	SUMMIT
Number of cars......	60	60	60
Number of cuts.....	50	50	50
Crew consists of....	Engineman Fireman Conductor Two trainmen	Engineman Fireman Conductor Six trainmen	Engineman Fireman Conductor Six trainmen
Time consumed	2 hours	1 hour 15 min.	30 minutes
Wage expense	$2.44	$2.55	$1.02
Distance traveled by locomotive, in feet.	24,750	24,750	6,000

In the tail and pole methods the locomotive travel was estimated at 250 ft. in each direction for each cut made or 500 ft. for the round trip. In the summit method it was estimated at twice the length of the train to cover the return trip. Mr. Bardo comments on these tests as follows:

"It will be noted from the table that the last, or hump method, requires one-quarter the time of the push and pull, and two-fifths of the time of the poling method. In engine service the hump method requires one-quarter the reverses of either of the other two. In the number of cars handled there is no difference between the poling or hump systems, both showing an astonishing economy over the push and pull method. In handling the train by the first named method, assuming that the train was moved 250 feet in each direction, for each cut, we find that the engine service is equivalent to 137 car miles. In addition to the amount of time required to handle a train under the push and pull method, due consideration should be given to the question of expense on account of damage to lading and equipment by air-brake and reversing shocks. The figures above given were obtained from actual tests, under favorable grade conditions for the first method, and similar, though unfavorable track facilities for the other two. The results above noted indicate plainly the superiority of the hump method over either of the other two, for the classification of trains."

There is much to be said, however, in favor of pole switching and especially where it has the advantage of gravity assistance. The author had charge of a large coal yard where 1,428 loads were passed through in 10 hours and 20 minutes, or an average of 138 cars an hour. This was done with a ram and an assisting grade extending throughout the entire yard. All of these cars were passed over scales and about half of them were weighed. The scales were not automatic.

The record was a remarkable one, but it is only proper to add that the conditions of weather, character of lading (coal), heavy loads, and good running cars, daylight hours, trained and reliable help were all favorable.

Some of the best types of poling yards are the Galewood (Chicago) yards of the Chicago, Milwaukee & St. Paul; Philadelphia yards, Pennsylvania; Harrisburg yards, Pennsylvania; Williamstown (Massachusetts) yards, Boston & Maine; Wilmington (Delaware) yard, Pennsylvania; Denver yard, Union Pacific; Columbus yard, Pittsburg, Cincinnati, Chicago & St. Louis; Packerton yard, Lehigh Valley; Port Jervis yard, Erie; East Detroit yard, Michigan Central; Hawthorne (Illinois) yard, Chicago, Burlington & Quincy; and West Seneca (Buffalo) yard, Lake Shore & Michigan Southern.[1]

Diagrams of these yards are well worth careful study, not only by those interested in designing new yards or remodeling or revising existing yards, but also by those interested solely in the operation of yards. It is a mistaken idea that points in the operation of terminals may be obtained only by watching and studying actual movements; the author has, in his own experience, derived many good lessons in operating from the study of plans of terminals built on different lines from those of which he was in charge.

A plan of a divisional yard, indicating general principles of construction, and another of a yard to make use of gravity in both directions, prepared by Mr. W. C. Cushing, Chief Engineer Maintenance of Way, Pennsylvania Lines West, some years ago and printed in the *Railroad Gazette*, January 4, 1901, page 1, are also worth a study of the many excellent ideas embodied.

One of the strongest points in favor of the pole yard or pole system of switching is the facility with which cars may

[1] Plans and descriptions of some of these yards may be found as follows: Columbus yard, *Railroad Gazette*, 1892, page 222; Packerton yard, *Railroad Gazette*, 1892, page 362; Denver yard, *Railroad Gazette*, 1891, page 229; Hawthorne yard, *Railroad Gazette*, 1889, page 818; East Detroit yard, *Railroad Gazette*, 1897, page 780; New Hawthorne yard, *Railroad Gazette*, 1898, page 931; Williamstown yard, *Engineering News*, May 31, 1894, page 443; Port Jervis yard, *Engineering News*, January 9, 1896, page 21.

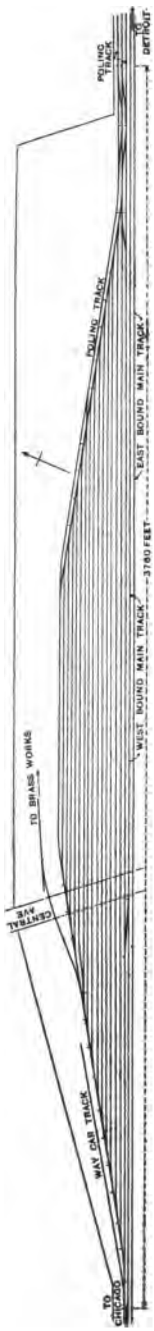


FIG. 18 — Poling Yard at East Detroit, Mich. — Michigan Central.

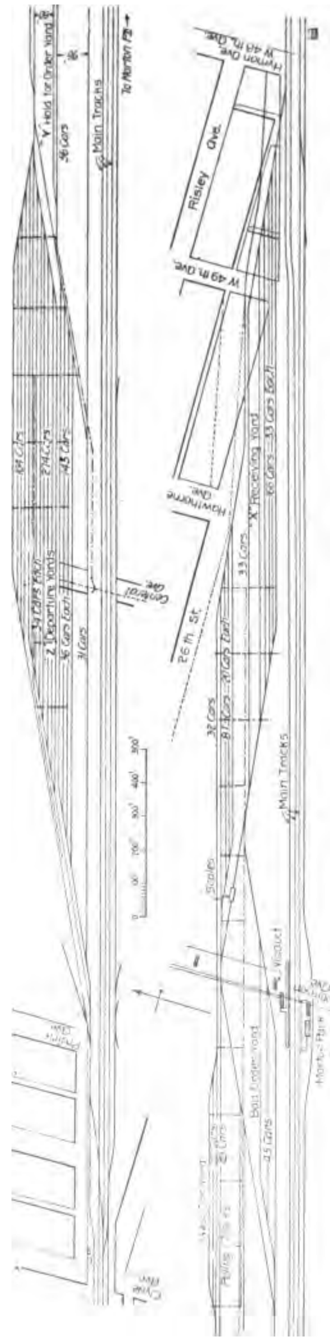


FIG. 19 — New Poling Yard at Hawthorne, Ill. — Chicago, Burlington & Quincy.

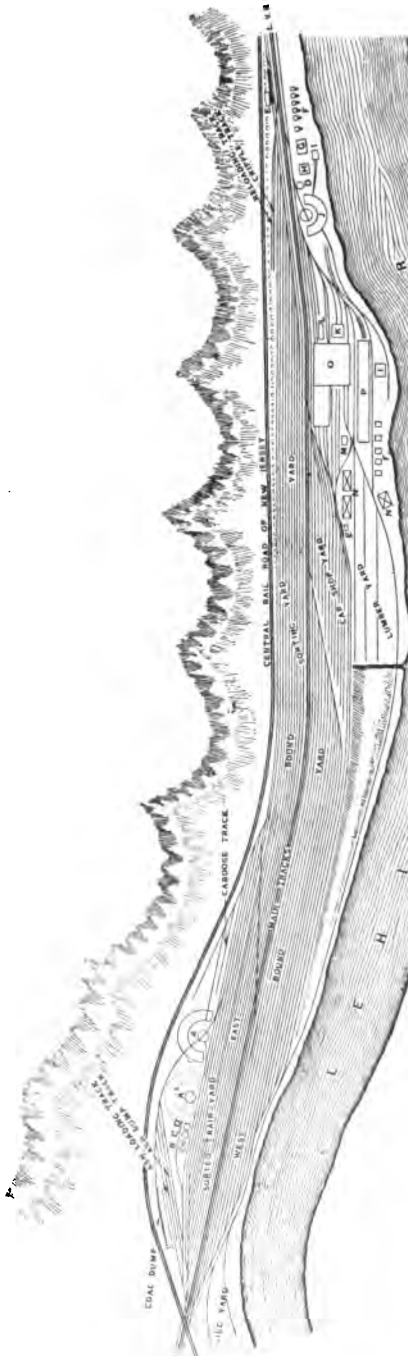


FIG. 20 — Poling Yard at Packerton, Pa. — Lehigh Valley.

be started at varying speeds in entering the separation or classification yard. This feature is particularly advantageous in colder climates where there is a greater range between the extremes of temperature. Some kinds of cars, or cars of certain construction, will run more readily than others. Those with well-supported, stiff body bolsters, preventing heavy riding on side bearings will run more rapidly, or with less start, particularly through curves, as in entering ladders, and in leaving the ladders and entering the body tracks. Loaded cars will run better than empty cars, and heavy loads better than light ones. As the temperature drops cars run harder, and in the face of a head, or, what is worse, a side wind, or on snow-covered tracks, more start is needed as the cars will slow down to a stop in a short distance. The pole method has its advantages in such cases as the start can be made sufficiently strong to meet the adverse conditions.

It is to be said too, as one of the arguments in favor of the pole system that the engine starting the cars works close to the front. The men in charge are therefore able to keep themselves informed as to the clearance distance of each body track and to start cars accordingly. They have the advantage too, of receiving signals at short range. This advantage is particularly apparent during snow, rain, or foggy weather. It prevents damage to cars and contents.

CHAPTER XI

SUMMIT SWITCHING

The summit or "hump" method consists of a natural or constructed hump, in the lead track or a part of the ladder, anywhere from 6 ft. to 10 or 12 ft. in height, with a grade on either side ranging all the way from 0.4 to 3 per cent. usually reducing on the descending side. The body tracks may be level but a light descending grade greatly facilitates the work of breaking up trains.

Mr. Cushing says:

"The hump or summit yard seems to have become the standard with some railroad companies and is added to yards with natural gravity, in order to avoid poling. Time and expense are saved. One of the most efficient poling yards in the country is the Pennsylvania Railroad eastward yard at Altoona, yet it is to have the summit. About all of the large and important yards, as well as many of the smaller ones, which have been built within the last five years, have been planned to be operated by gravity switching, aided by the summit to give the cars their initial start after separation from the train. So important is the assistance of gravity in switching now regarded, that traffic is even reversed in direction, a violation of a cardinal principle in yard design, in order to take advantage of ground, which, unfortunately, was not given the proper topographical features to suit the railroad company. Such yards are at the tide-water terminal of the Pennsylvania at Greenville, N. J. (New York City), and at Logansport, Indiana, and Sheridan, Pennsylvania, on the Pennsylvania Lines. In other cases, the topography, instead of the traffic, has been reversed at great cost, in order to have gravity assist in the proper direction, as was done for the new westward yard at Altoona on the Pennsylvania. It is now a common proceeding to throw up humps on a level prairie or river bottom and make a gravity yard. Probably the largest undertaking of this kind is the yards, or perhaps more properly, cluster, of the Chicago Union Transfer Railway at Chicago. They were projected in 1899, and one unit of the ultimate group of four was built on the level prairie in 1901-1902. This was put into service in 1904. The company owns 3,700 acres of land and the yards are 14,500 feet long. They now contain 105 miles of track, and will hold 14,000 cars. The yard plan and summit profile were illustrated in the *Railroad Gazette* for March 14, 1902, and are quite different from the original plan, which was given in the issue of March 8, 1901.

Another very large yard similarly located is the one at Conway, near Pittsburg, on the Pennsylvania Lines. It was originally built in 1883 as a poling yard, but grew to be too large for poling without the assistance of gravity. As the location is a river grade, the most serious

trouble was with the eastward switching, and accordingly a summit was built for that movement in 1901. The work done was not radical enough, especially for empty cars in winter, and, in 1903, summits were built for the westward movement, and the eastward one was redesigned."

So far as can be learned, the first summit yard built in this country was at Honey Pot on the Sunbury division of the Pennsylvania Railroad, in 1890; although this method of switching was in use in Germany and France much earlier. One of the few points at which actual tests of service were made, and the results made known, was at Honey Pot, where on November 2, 1899, 176 cars were handled in six drafts, each car a "cut," and weighed as it passed over the scales. This work was done in one hour and three minutes, almost three cars a minute, a most remarkable performance.

The summit system is used in the terminals of the Chicago Clearing Yards, of the Chicago Union Transfer Railway, near Chicago, and this is perhaps the most elaborate terminal for handling and distributing freight-cars in this or any other

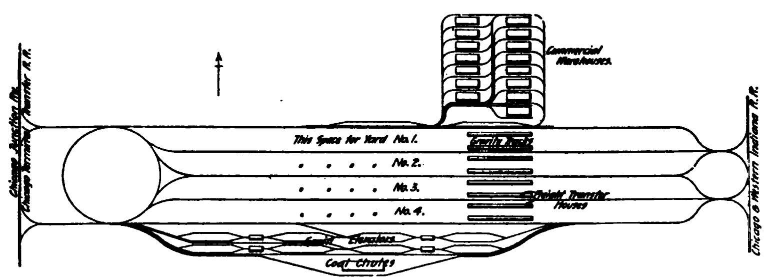


FIG. 21 — General Plan of Chicago Clearing Yards.

country. It is intended to accomplish the receiving, separating and delivering of incoming freight and the collecting, assembling, and despatching of outgoing freight for the entire city of Chicago and the 23 railroads centering there. The interchange of freight cars is handled by belt roads and by the railroads direct. The methods are of necessity, crude, awkward and expensive. Nothing more confusing or unsatisfactory can well be imagined than the manner in which the lines generally are compelled to get in and out of the city with their passenger trains, to say nothing of freight, and with the in-

numerable crossings of one road with another at grade, street and highway crossings at grade and the circuitous routes followed to reach destination. Some general and more direct method was needed. This the clearing yards were built to supply.

The clearing yards are summit yards, assisted by gravity in both directions. They occupy a tract of land 13,000 ft. long and 670 ft. wide, which is connected with all of the belt or switching lines. The general plan consists of two sets of classification tracks, each 2,400 ft. long, covering the full width of the yard; double ladders at each end, leading away from an artificial summit; receiving tracks 1,600 to 3,200 ft. long, located north and south of the gravity summit. There are also overflow tracks lying parallel to the classification yards.

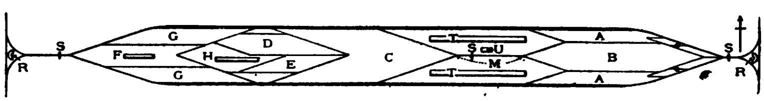


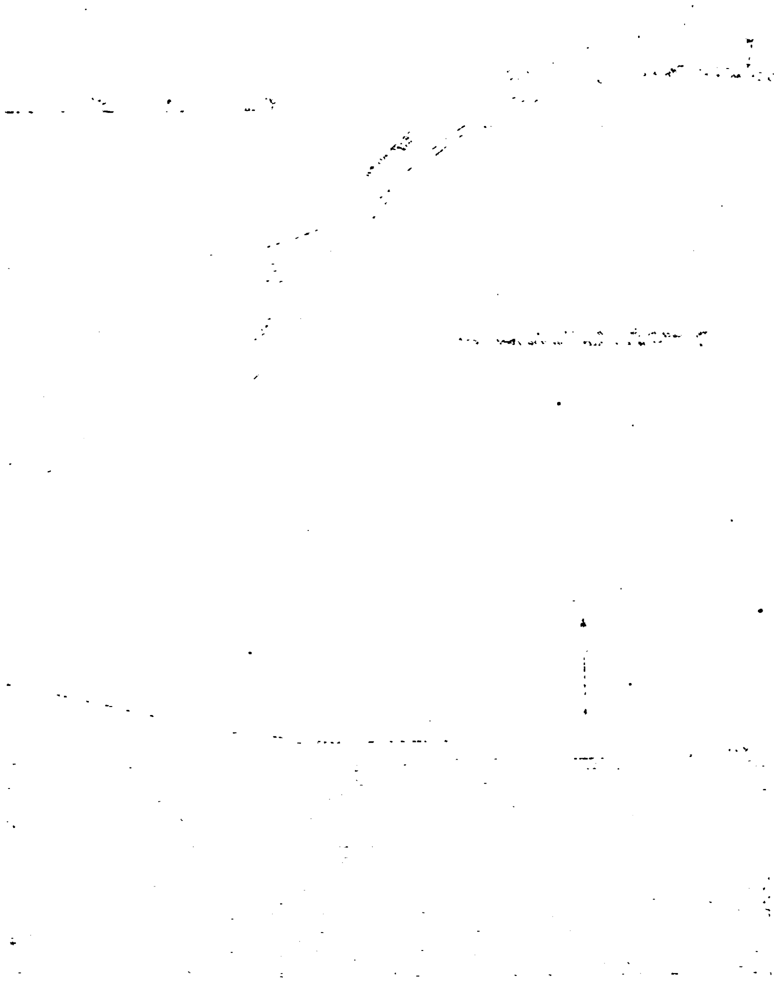
Fig. 22 — Plan of General Yard No 2, Chicago Clearing Yards.

A = Departure Yards,	*18 tracks, capacity,*	*1250 cars.*	*H = Ice House.*
B = Receiving Yards,	*22*	*3500*	*R = RoundHouses.*
C = Classification Yards,	*39*	*3500*	*S = Signal Towers.*
D = Storage Yards,	*15*	*600*	*T = Transfer House.*
E = Fast Freight Yards,	*11*	*300*	*U = Power Plant.*
F = Repair Yards,	*9*	*150*	*M = Gravity Mound.*
G = Departure Yards,	*22*	*1250*	

Space has been reserved for storage tracks, repair tracks, icing-houses, etc. There are 49 tracks alongside of each other which cover a width of 660 ft. Body tracks are spaced 13.3 ft. center to center, while thoroughfare or running tracks are 14 and 15 ft. center to center.

A poling engine can be used when needed on account of cars stopping short by reason of heavy winds, cold weather or snow, all of which conditions have to be reckoned with in that territory. A light engine and car is used to return the car riders and runs on the center track, or, on one or both of the run-around tracks on the sides of the classification tracks.

The gravity summit has 1.5 per cent. grades for a short distance each side to give the cars a quick start from the summit. This is followed by a grade of 0.9 or 1 per cent. for a distance of 1,800 ft. dropping off to a grade of 0.5 per cent. for 300 ft. The foot of the gravity lead is about 400 ft. beyond



the ends of the classification ladders. The apex of the summit is 22 ft. above the elevation of the level body tracks.

The thoroughfare and gravity tracks are laid with oak ties; elsewhere cedar, 2,800 to the mile and 75-lb. rails are used throughout. The summit required 400,000 cubic yards of sand. The yard contains about 450 switches, 120 of which, along the ladders of classification tracks, are operated by electro-pneumatic cylinders made by the Union Switch & Signal Co., and are controlled by push-button machines in a tower, similar to the arrangement which has been in use in the Altoona yards for a number of years. The gravity tracks are lighted

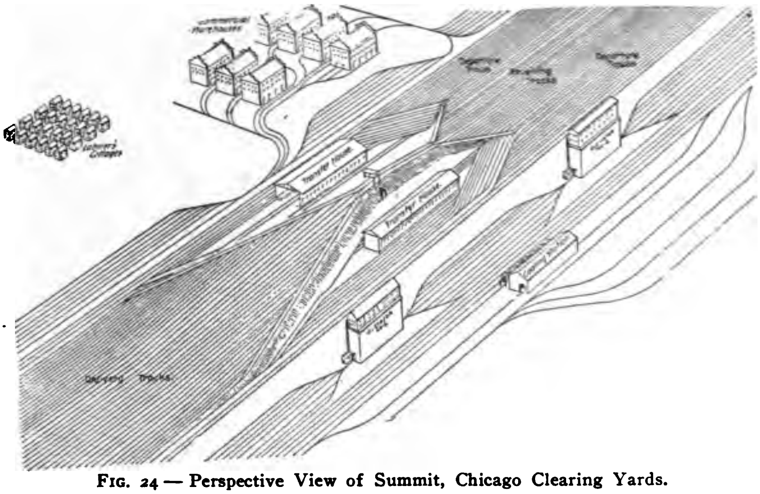


FIG. 24 — Perspective View of Summit, Chicago Clearing Yards.

by electric arc lights, arranged on poles, at intervals of 300 ft. at the sides of the classification ladders. These lights are shaded on the side toward the signal tower. This throws the light ahead on the classification tracks, but protects the eyes of the tower men and the brakemen, riding cuts of cars, from the direct rays. Of the 450 switches 425 will be lighted by incandescent electric lights of 8 candle power.

It is expected that the Chicago clearing yards will be able to receive and distribute 4000 cars a day in each direction when they are in complete working order.

Summit yards have recently been made at DeWitt, N. Y., on the New York Central. A divisional yard was built con-

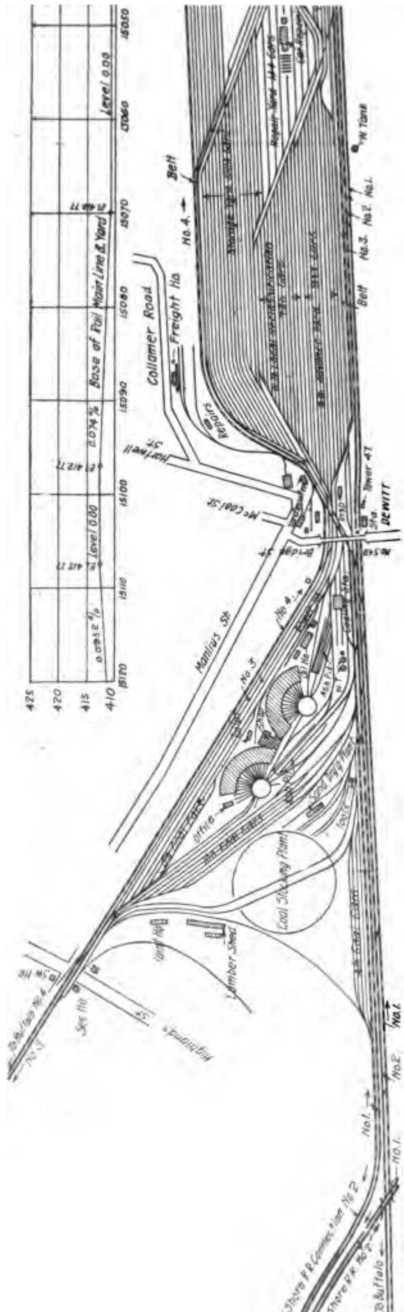


FIG. 25a — Plan of West Half of DeWitt, N. Y., Yards, New York Central & Hudson River.

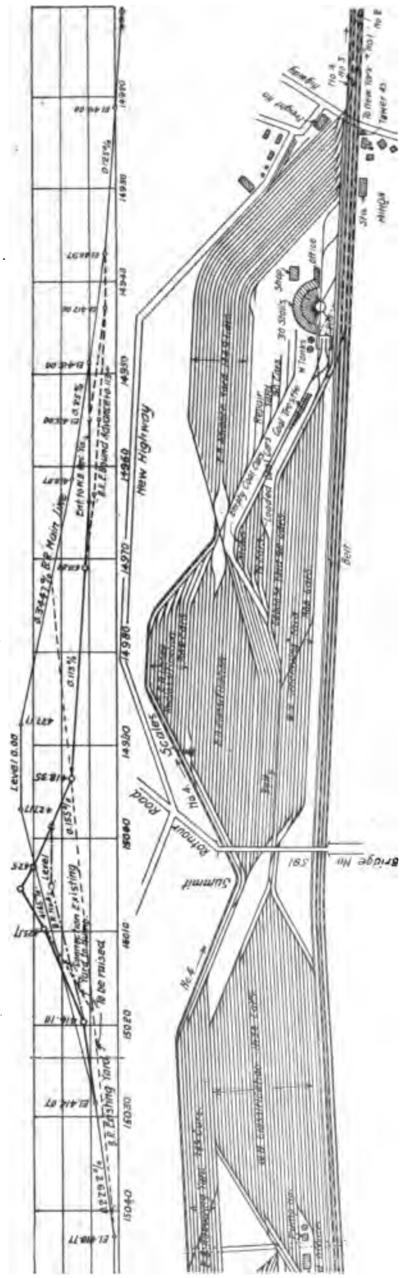


FIG. 25b — Plan of East Half of DeWitt, N. Y., Yards, New York Central & Hudson River.

sisting of complete systems of receiving tracks, gravity classification tracks, and advance tracks in each direction.

For the eastbound movements, trains enter the receiving tracks for that direction where the engines cut off and return by the belt track to the engine houses. The cars are then passed over the hump into the eastbound classification yard, and there are assembled and advanced as trains into the eastbound advance yard. In connection with this eastbound movement there are caboose tracks, where the cabooses are cut off in a convenient location for coupling to westbound trains. There are, also, separate eastbound reclassification tracks for making up local trains. It is the intention to also develop these eastbound classification tracks with a separate system of advance tracks which will adapt the yard for both local freight and fast freight service. There are also car repair tracks.

In handling the westbound movement, trains enter the westbound receiving tracks, where the engines cut off and return east by the belt track to the engine house. The cars are passed over the hump or summit, shown on the drawing, into the classification tracks, from which they are assembled into trains and taken into the westbound advance tracks. Car repair tracks are provided and local reclassification tracks for westbound movements.

In addition to the general movement of heavy-tonnage, slow-speed freight traffic, there are also handled in the yard fast freight trains, aggregating ten per day in each direction. The eastbound fast freight trains pull directly into the eastbound reclassification tracks, change engines and cabooses, and then proceed. The westbound fast freights pull directly into the southerly tracks where cabooses and engines are changed, and the train then moves on. The only switching of fast freights is the removal of any cripples which may be found, or the filling out of the trains with additional cars, which are held convenient for this purpose.

The summit grades are somewhat different from those shown on the drawing and are substantially as follows: With eastbound traffic, which consists principally of loaded cars,

an accelerating grade of 2½ per cent. is had for a distance of 150 ft., with a grade of 1 per cent. for a distance of 1,200 ft. through the ladder tracks; the balance of the classification tracks being practically level.

In the westbound yards, which handle many empty cars, and where the prevailing winds against traffic are heavier, the accelerating grade is about 4 per cent. for a distance of 150 ft. with a 1 per cent. grade for a distance of 1,200 ft. The remainder of the classification tracks are on a slightly descending grade of about 0.25 per cent.

Every car movement is continuous, as far as practicable, toward destination; and the switching in practically all cases is done over the hump. From 1,500 to 2,500 cars are handled daily in each direction. Fifty trains may be handled each way during 24 hours, or 3,500 cars each way making a total of about 7000 cars per day.

Interesting studies of the summit method of switching are to be found in the yards at:

Pittsburg — Pittsburg & Lake Erie.
Cincinnati, O. — Big Four.
Conway, Pa. — Pennsylvania Lines West of Pittsburg.
Harrisburg — Pennsylvania Railroad.
Altoona — Pennsylvania Railroad.
McKees Rocks, Pa. — Pittsburg & Lake Erie.
Haselton, O. — Pittsburg & Lake Erie.
Oak Grove, N. Y. — New York Central.
Coxton, Pa. — Lehigh Valley.
Oak Island, N. J. — Lehigh Valley.
Jersey City, N. J. — Lehigh Valley.
Greenville, N. J. — Pennsylvania Railroad.
Columbus, O. — P., C., C. & St. L.
DeWitt, N. Y. — New York Central.
Sheridan, Pa. — Pennsylvania Lines West.
Scully, Pa. — Pennsylvania Lines West.
Alexandria, Va. — Washington Southern.
Logansport, Ind. — P., C., C. & St. L.
Bradford, O. — P., C., C. & St. L.
Richmond, Ind. — P., C., C. & St. L.
Mansfield, O. — P., F. W. & C.
Cincinnati, O. — P., C., C. & St. L.

In the plans of types of terminals for light traffic and for heavy traffic prepared by Mr. W. C. Cushing and printed in the *Railroad Gazette,* Jan. 4, 1901, p. 1, particular attention was called to the feature of incoming engines passing to ash

pits under the summit thereby avoiding interference. This is an idea that might be profitably introduced in many summit yards. In the first yard, for moderate traffic, the summit feature is applied in the westbound direction. The switches at the entrance to the classification yard are thrown by a set of non-interlocked levers handled in the upper story of the tower. The movements are quickly made, and about 1,100 westbound cars can be passed through in 24 hours. It is considered capable of handling 1,500 to 2,000 cars if the classification tracks are kept cleared.

Mr. Cushing's second plan is that of a yard designed to meet a condition where the movement is heavy and classifications numerous. This terminal has a standing capacity of 12,360 cars and is estimated to take care of a business of 7,000 cars daily without crowding. It is believed that this could be increased to 10,000 cars by working eight engines simultaneously over the summit and providing ample road power to keep the cars moving away from the classification tracks. In each direction there are two receiving yards of 10 tracks each, from which the cars are to be fed into their respective classification yards of 36 tracks. The length of receiving tracks, which should be governed by local conditions, is in this case 74 to 90 cars. The classification yards have V-shaped ladders with No. 7 (8 deg. 11 min.) frogs on a No. 6 (9 deg. 3 min.) angle, making the ladders only 18 tracks long. When working two yards side by side it is quite likely that cars of the same classification will be in each, and it is therefore essential that the tracks be so arranged at the lower end that the cars on any track whatever can be pushed to any track in the departure yard. By the arrangement of ladders the tracks in the classification yards are equal in length, 40 cars each. Half of them are straight, the other half have but one light curve and the descending grade continues to the end of the yards. Caboose tracks are so arranged that cabooses may be dropped to trains by gravity. Ash tracks and coaling arrangements are such as to enable some engines to be worked around others and the "procession" feature is thereby avoided.

In some modern summit yards the receiving yard is practically reduced to one track and that is the track on which trains proceed to and over the summit. In other words, it is expected that trains will be switched as fast as they arrive, and, barring emergencies, this is in theory what every yard should be expected to do. When this arrangement works out in practice it insures carrying out the object of the yard, to provide a rapid means of collecting and classifying cars in order of destination or character of loading as they come in off the main line, and for despatching them again.

The new westbound classification yard at Altoona of the Pennsylvania is an interesting type of the use of the summit.

The Altoona yard consists, in part, of 15 classification tracks. The westbound main freight track divides into two tracks which are carried over the scales and summit. These form the only receiving yard. The lead switches to the ladder track are 800 ft. from the summit and the cars run 2,000 ft. down the body tracks. A record was made of 55 "cuts," 88 cars, in one hour, and 984 cars went over the summit in 12 hours of daylight working. In 24 hours 70 trains, 1,491 cars, were handled — a train about every 20 minutes.

An interesting experience in operating the Altoona summit occurred during the winter of 1903-4. As the nights got colder, in the Fall, the cars would not run to the end of the yard. This was partly due to the low temperature but some of it was supposed to be owing to the timidity of the brakemen setting up the hand brakes too tightly at the start. As the weather became colder the trouble increased. Light cars frequently could not be made to run to the ends of the tracks, although brakes were kept off. From the summit there was a 2.55 per cent. descending grade, and from the foot, well into the yard, the grade was 0.7 per cent. A crib and rip-rap arrangement raised the summit and a grade of 4.0 per cent. was made for a distance of 200 ft., which enabled the yard to be satisfactorily operated all winter and gave the cars sufficient start to run them through the classification yard.

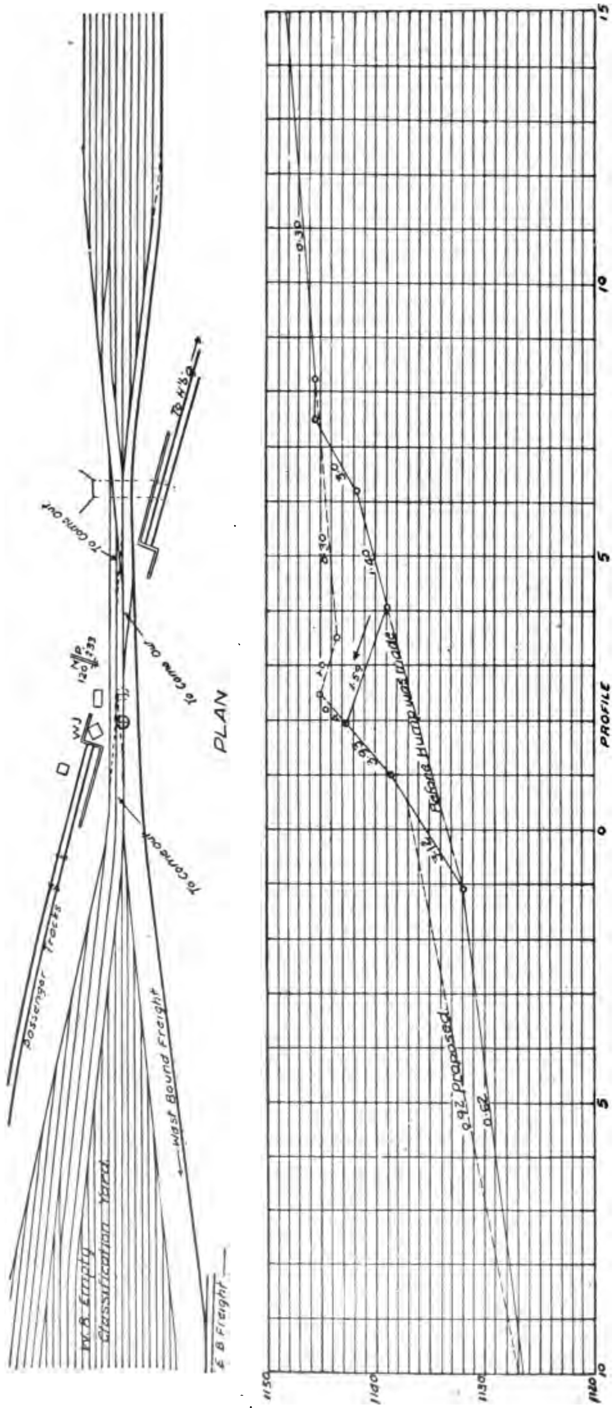


FIG. 26 — Plan and Profile of Summit, West Bound Classification Yard, Altoona, Pa. — Pennsylvania Railroad.

It has been shown that the internal resistance of trains in winter is one and one-half to two times as much as in warm weather, due largely to the difference in the coefficient of journal friction at high and low temperatures. Some of the trouble at Altoona was due also, to the yard being built on made ground and with the heaving of the track due to frost, more or less resistance at the wheel tread developed, which had little or no effect in summer. The temporary summit was not continued during summer because of the liability of wrecks from runaway cars with defective handbrakes or careless brakemen. The grade of 4.0 per cent. is perhaps the steepest used, so far, with the single exception of the Lake Shore & Michigan Southern at Elkhart, Indiana, where the eastbound track has a grade of 4.3 per cent. and the westbound track a grade of 5.0 per cent. The Elkhart yard is exceptionally long, however, and with the light prevailing grade of 0.16 per cent. the steeper summit grade is not objectionable.

In the September 30, 1904, issue of the *Railway Gazette* (London) the editor, Mr. W. H. Boardman, discussed the theory of summit yards as follows:

"When a train of cars, uncoupled either singly or in groups, or 'cuts,' is pushed over the summit, the leading car or cut plunges down the sharp grade at a greatly increased speed. This acceleration produces a time and space interval between each cut. It is desirable to know what conditions increase or decrease these intervals. The space interval may be disregarded if the speed at the last switching point from the lead, or ladder, is twice the speed at the summit. It is plain that if two equally easy running cars were instantaneously set free on a uniform down grade, they would keep together — there would be no interval between them; but the change from level, or up grade to down grade allows the front car to get away at higher speed during the time that the following car moves its length on the level, and this time becomes the time interval between them.

"This time interval between car centers is a constant all the way down the incline and through the yard, as will appear quite clearly when the reader recalls that all the cars would run their distance from the summit to the same stopping point in the same amount of time; and that the leading car has just a car length advantage over the following car in beginning its acceleration. The length of wheel-base has nothing to do with the case. Sir George Findlay, in his valuable book, 'The Working and Management of an English Railway,' seems to have been in error on this point. If two cannon balls were sent in a guiding trough over a summit, the time interval between their centers as they rolled down the incline would vary only with their diameters, and bear no relation to positions of the points of support.

"It makes no difference (assuming equal ease in running) whether the car is poised on a pony truck, or supported by 8 wheels with either a long or short wheel-base. The elements controlling the time interval between car centers are: Over-all car length, speed in approaching the summit, and increased speed after passing over the summit. Therefore, if a train of uncoupled cars, each one 40 ft. long, approaches the summit at one mile an hour, each car is moving its length in 27.27 seconds, and, theoretically, this will be the time interval between the centers of the cars as they rush down the incline to the yard, where the switch points are moved to turn each car to its proper siding. (In this discussion we are considering cuts of one car each.) But it is not sufficient to compute the intervals between the centers of the cars, for the buffers will come in collision long before the centers touch each other, and meantime undesirable things are happening.

"There needs to be deducted from the interval between the centers the time taken to run a car length in the yard. For example, if the initial speed at the summit is one mile an hour, and if the grade from the summit is adjusted to produce a speed of 3 miles per hour in the yard, where the car would then be moving its length in 9.69 seconds, the interval between the buffers would be 27.27 seconds — 9.09 seconds = 18.18 seconds. The time interval between the buffers of any two adjoining cars is, therefore, not a constant, it is a variable on the incline and in the yard. It decreases in proportion as the cars slow down in the yard. The derived formula, which is true for any point on the incline or in the yard, is:

"Time interval between buffers = Time of car moving its length at the summit — Time of car moving its length on the ladder.

"Reversing this formula in order to find at what speed cars can be fed to the summit.

"Car-length time on the summit = Car-length time on ladder + Time interval needed for moving the points.

"If the train is to be broken up in sections of more than one car each, the same formula is applicable if the length of each section is substituted for the car length."

The ease with which the summit can be utilized to facilitate separation in large and small yards and the advantage of operating yards under this system economically, with light traffic, commend it for general use. There are many sizes of humps, or gravity mounds, with varying rates of grade, both on the ascending as well as on the descending side, and the distances differ throughout which the latter grade continues. In the diagrams prepared by Mr. Bardo, Figs. 27-29, the profiles of some of the principal gravity mounds are shown.

The gravity assisting grade for a summit yard may be too long or too great. This is a most difficult problem to work out, as no hard and fast rules can be made to cover all cases. Local conditions govern, and climate is an important factor.

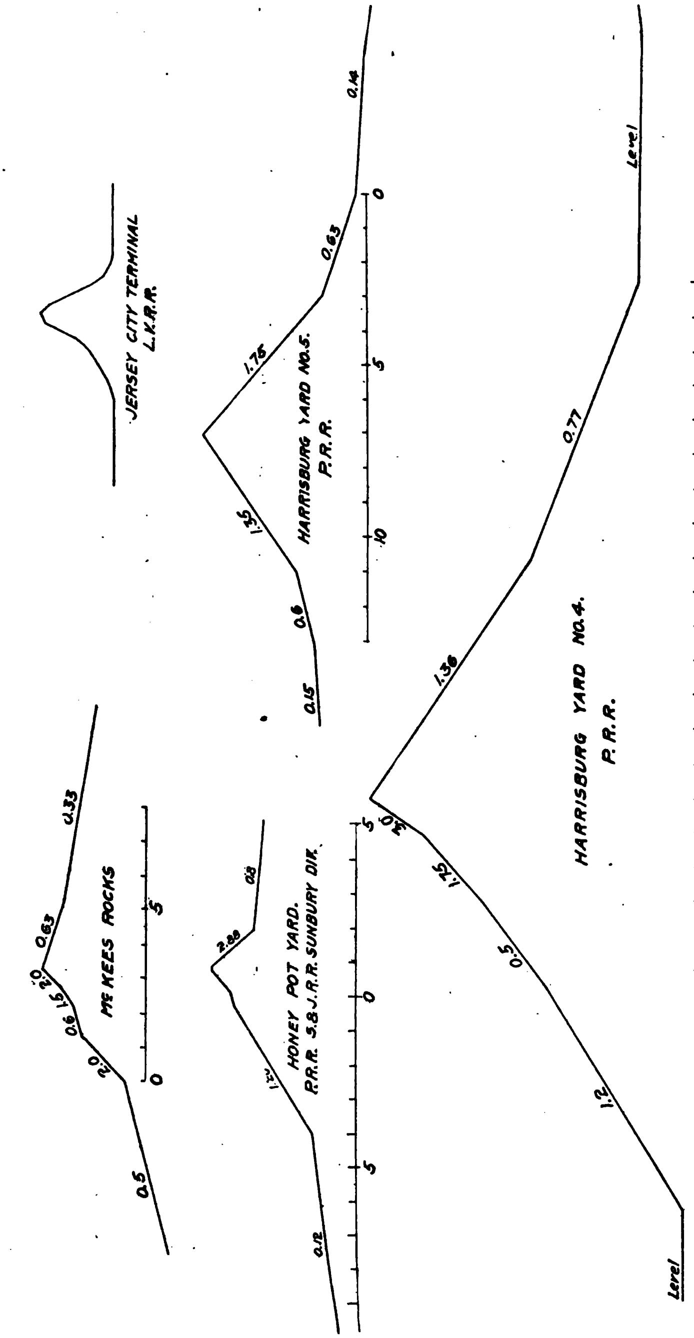


FIG. 27 — Comparative Profiles of Freight Yard Summits.

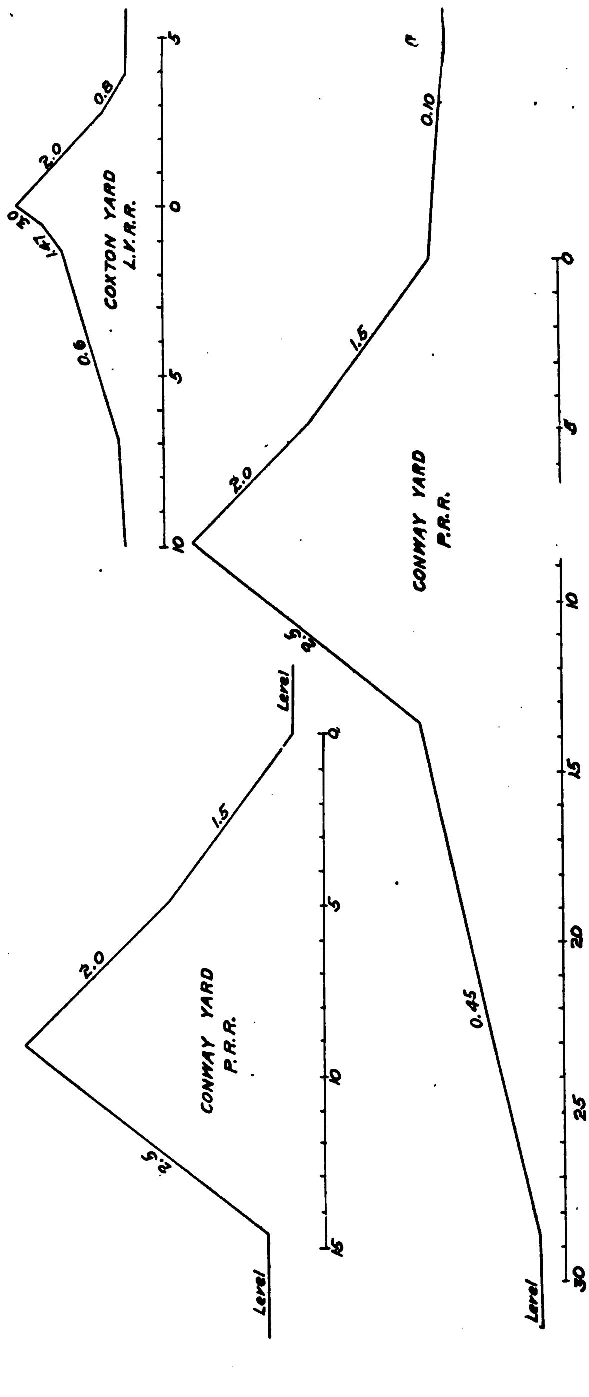


FIG. 28 — Comparative Profiles of Freight Yard Summits.

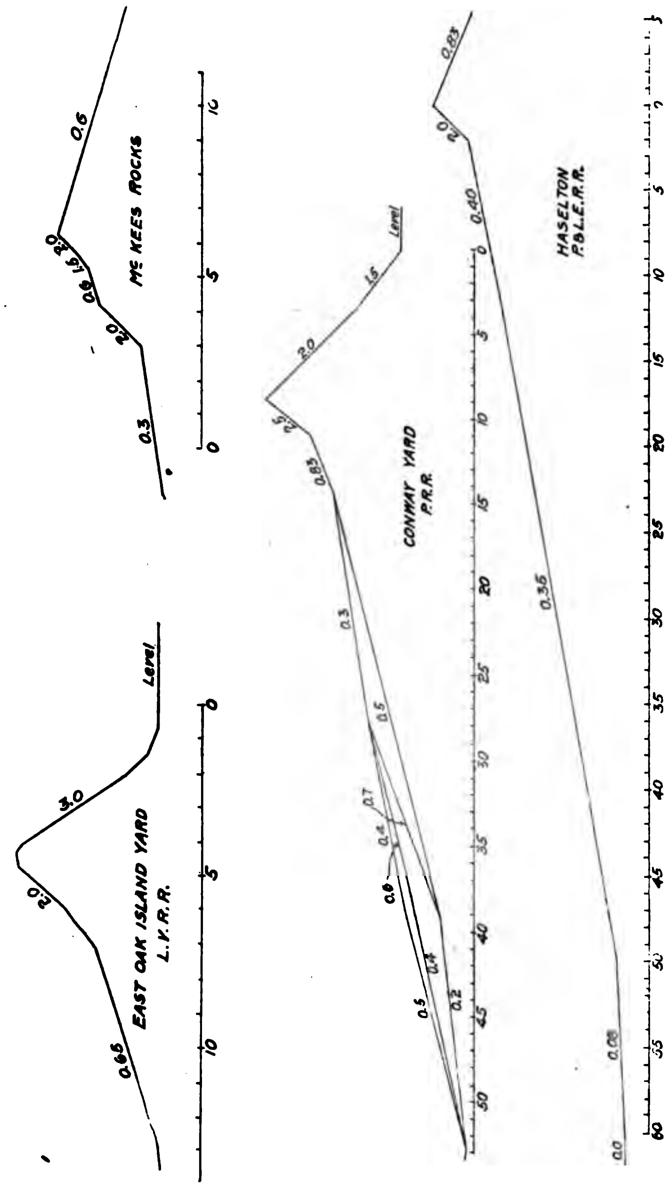


FIG. 29 — Comparative Profiles of Freight Yard Summits.

A separating yard with a rather heavy grade throughout would tend to increase, rather than to decrease, the expense of operating, as it would necessitate car riders accompanying each cut until stopped, thereby making a greater force of car riders necessary. A uniform, moderately heavy descending grade part way, bringing up on nearly level track, is a very good arrangement, provided the length and rate of grade can be nicely adjusted to balance the kind of cars and commodities handled, together with the temperature and wind resistance during the greater part of the year. In the Honey Pot yard of the Pennsylvania the author has seen classifying done over the summit without car riders accompanying the cars. The freight handled, however, consisted wholly of coal. It may be remarked that the ground was well covered with coal. In a yard with a continuous descending grade of considerable fall, say 0.6 or 0.8 per cent. or greater throughout, difficulty is experienced by outgoing road engines, when they would find it necessary to back up their trains, or part them, to make couplings.

Mr. W. C. Cushing has tabulated a summary of summit grades which is reproduced in full, with his comments:

"As it is very laborious to make a study of a collection of information without systematic tabulation, the principal characteristics bearing upon a study of proper grades for humps have been gathered into the accompanying table. Columns 5 and 8 have been added by calculation from Wellington's 'Economic Theory of Railway Location,' as explained at the foot of the table, to assist in the comparison, for the velocity at the foot of the grade is the important factor. Nothing has been added to these velocities for the initial velocity of the cars as they are pushed over the hump. It is fully realized that the velocities are approximate only, for there is such a vast difference in the freedom of running of cars, as between loads and empties, gondolas with coal and ore and box cars with merchandise, and between the seasons, winter and summer. It is impossible also to take account, except by experience, of the turnouts from the ladders, and the inequalities of the track. Consequently the different hump profiles are the result of tests, more than anything else. It is thought that the speeds in column 5 are not far out, but those in column 8 are probably too great. In calculating both columns, an allowance was made for rolling friction of 8 lbs. per ton, but this should undoubtedly be greater on the ladders. It is known, for instance, that cars sometimes stop on the old eastbound ladders of Conway, but as winter weather materially alters the conditions, it does not seem to be worth while to try and arrive at greater accuracy, except by experiment under both winter and summer conditions. Nevertheless, the figures given have

TABULATED SUMMARY OF HUMP OR SUMMIT GRADES.

Yard.	First grade from summit. Grade per cent.	Fall, ft.	Horizontal length, ft.	Velocity at foot, m. p. hr.	Average remaining grade from 1st grade to bottom of ladders. Fall, ft.	Horizontal length, ft.	Velocity at foot of ladders, m. p. hr.	Grade of ladders, per cent.	Grade of classified yard, per cent.	First grade from scales, when any, per cent.	Distance from summit to center of scales, ft.	Standing car capacity of all yards,	Character of traffic.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	
Enola ....E.	3.5	4.2	120	10.2	5	500	19.4	1.0	0.1	None.	...	10,705	Coal.
Enola ....W.	3.5	3.5	100	9.3	10	700	23.3	1.4	0.3	"	...		Empties.
Altoona ....W.	3.9	5.8	150	12.2	13.8	1,500	27	0.92	0.29	"	...	10,500	" and mdse.
Harrisburg ...W.	3.6	5.4	150	11.6	14.6	1,100	25	1.5 & 1.2	0.0	"	...	10,015	" and mdse.
Conway ....E.	2.5	5.5	220	11.4	15	2,800	21.9	0.5 & 0.3	0.3	0.83	250	8,967	Ore, grain and mdse.
" ....E.	3.0	6.3	210	12.4	13	2,000	24.3	1.0 & 0.3	0.0	1.80	350		Ore, grain and mdse.
" ....W.	1.8	8.6	480	13.7	8.4	1,800	19.7	0.6	0.14	1.80	220		Coal, coke and mdse.
Gr'nville (mdse) E.	2.5	1.3	50	5.4	....	.....	....	1.0	1.0	None.	...	7,842	Merchandise.
Gr'nville (coal) E.	2.0	1.0	50	5.5	....	.....	....	1.0	1.0	2.0	100		Coal.
Columbus .....E.	2.0	4.8	240	10.4	9	1,000	22.2	1.0	0.8	2.5	280	3,402	Mdse., grain & empties.
Columbus .....W.	2.5	8.8	350	14.4	7.5	750	25.6	1.0	1.0	2.5	190		Coal, coke & mdse.
Alexandria ....N.	2.5	2.5	100	7.7	11.5	900	22.6	1.0	0.35	2.0	170	3,127	Mdse. and produce.
Alexandria ....S.	2.5	2.5	100	7.7	13.5	1,100	23.7	1.0	0.30	2.0	170		
Edgemoor .....N.	1.54	0.8	50	4.0	....	....	....	1.5	...	1.5	80	2,819	
Edgemoor .....S.	1.0	0.7	70	4.0	5.25	300	14.6	1.75	0.0	1.75	80		
Logansport ...E.	2.4	3.0	125	8.4	7	800	18.7	0.5	0.04	On sum't	...	2,124	Mdse., grain & empties.
Logansport ...W.	1.45	3.6	250	8.4	2	450	10.7	0.43	0.4	On sum't	....		" coke and coal.
Crestline ......W.	3.0	7.5	250	13.5	2	400	16.8	0.75	0.3	None.	...	1,784	" coke and coal.
Marysville ....E.	2.5	6.5	260	12.4	12	1,000	27.4	1.2	0.0	2.5	110	1,756	
Marysville ....W.	2.0	4.6	230	10.2	8.4	700	22.7	1.2	0.36	None.	...		
Scully ....E.	2.5	2.5	100	7.7	13	1,000	20.5	1.3	0.5	2.5	150	1,740	Coal.
Bradford .....W.	3.0	2.4	80	7.6	3.2	700	10.6	0.45	0.45	None.	...	1,715	Coal, mdse. and empties
Ebenezer ......N.	1.75	14.9	850	18	0.0	0	18	1.75	0.57	1.75	120	1,620	
Chicago, 55th St. E.	3.0	4.5	150	10.5	3.5	700	14.9	0.5	0.17	0.5	330	1,278	Mdse., grain & empties
Chicago, 55th St. W.	3.0	4.5	150	10.5	3.5	700	14.9	0.5	0.5 & 0.05	0.5	400		Mdse. and coal.
Honey Pot ....W.	2.0	0.8	40	4.2	5	500	13.4	1.0	0.12	1.2	90	1,194	Coal.
Sheridan ......E.	1.67	2.5	150	7.3	6	700	16.8	0.74	1.0	1.55	170	1,103	Coal.
Richmond .....W.	2.5	2.5	100	7.7	2	400	11.0	0.25	0.25	None.	...	745	Merchandise.
Linwood ......W.	3.0	3	100	8.5	4	400	16.8	1.0	0.0	On sum't	0	656	"
Mansfield .....E.	2.5	3.2	130	8.7	4	600	15.3	0.2	0.2	1.0	250	630	" & empties.
Mansfield .....W.	2.5	5	200	10.9	2.5	400	15.9	0.2	0.2	None.	...		" & coal.
Chic., Clear. N.&S.	2.5	5	200	10.9	19.8	2,200	28.5	0.9	0.0	None.	...	14,000	Not in use.
Youngwood ....W.	1.74	1.4	80	5.4	....	.....	....	1.3	0.3	2.0	120	......	Coal and coke.
Hollidaysburg	2.0	1.0	50	5	....	.....	....	2.0	0.9	2.0	100	......	Coal.
Waverley	1.5	9	600	13.6	....	.....	....	1.5	0.5	None.	...	......	
DeWitt ....E.&W.	1.0	2.5	250	6.5	....	.....	....	...	...	None.	...	......	
Winnipeg ..E.&W.	3.7	11.1	300	16.7	....	.....	....	...	0.0	On sum't	0	......	
Elkhart ......E.	4.3	12.9	300	18.1	....	.....	....	...	0.16	...	...	......	
Elkhart ......W.	5.0	15	300	19.7	....	.....	....	...	0.18	...	...	......	

In calculating columns 5 and 8, the following data were used: A single loaded car weighing 150,000 lbs. = 75 tons; rolling friction = 8 lbs. per ton; grade acceleration = f = 20 x rate of grade per cent. (Wellington, p. 340); grade of repose, or grade to balance resistance to motion = 4%. Wellington's "Railway Location," p. 335, Table 118. No initial velocity included in Column 5.

some value for comparison, because the method of comparison is quite largely employed in yard design. If the resistances to motion were assumed to be about 13 lbs. per ton instead of 8, the car would stop half-way down the Conway ladders, and this, as stated, does happen under certain conditions.

"But, to begin at the bottom. If the rolling friction be taken at 8 lbs. per ton, the grade of repose, or grade required to overcome this, the resistance to motion, and keep the car moving uniformly with the initial velocity, is 0.4 per cent. Therefore, the grade of the classification yard should be about 0.4 per cent., certainly not less than 0.3. We have testimony that yards with these grades are quite satisfactory, Logansport, Crestline, Bradford; whereas Richmond with 0.25 needs revision, by raising the hump. Mansfield is giving satisfactory results with 0.2, but its humps are higher, and the velocity greater than at Richmond. The same is the experience at Linwood. In other words, if a lesser grade than 0.3 per cent. for the classification yard must be used, on account of cost or physical obstructions, the resistance to car movement must be overcome by increased entrance velocity. Notice the case of Altoona, where the traffic consists largely of empty cars, and the hump is about to be raised for the second time since construction. The old eastward hump at Conway had to be nearly doubled in height, because the classification yard is on a level. A second one, now being built, will have a 0.3 grade by dipping below the yard grade. The low grades of the classification yards at Chicago, 55th Street, have necessitated the construction of high humps, which give pretty considerable velocities.

"The track irregularities, and the switch turnouts from the ladders, offer increased resistances, which are met by increasing the grade on the ladders. This grade should be enough more than 0.4 per cent. to keep the car moving at the entrance velocity, as in the case of the classification yard, and experience must determine what it should be. A study of the table seems to show that the preponderance of opinion is in favor of 0.5 per cent. to 1.3 per cent. in cases where coal, ore, and minerals are the principal freight, and from 0.92 to 1.5 per cent. where the cars are largely empties, while a grade for merchandise would be somewhat between. The writer favors from 0.75 to 1.25 per cent. for minerals and merchandise, and from 1.25 to 1.5 per cent. for a preponderance of empties.

"The remaining grade of importance is the first one from the summit, because all others intermediate between it and the ladder grade simply form a vertical curve to join them. The object of the first grade is to impart the required velocity quickly so that the different cuts will separate from each other a sufficient distance to allow the switches to be thrown, and its length is dependent upon the vertical fall required to impart the velocity, and the maximum length of cuts. The number of cars in a cut is another one of the reasons why precise mathematics cannot be applied to this problem. With long cuts, the front end will be quite a distance down the slope before the whole cut begins to acquire much velocity. Although this detail in the case of the yards under discussion is not known in all cases to the writer, it is reasonable to assume that where the initial grade is short, the cuts are likewise short.

"In general, where there are no scales on the slope, and the cuts are to be short, the initial grade is steep and short, say from 3 per

cent. to 4 per cent., for a distance of from 50 to 150 ft. A good grade is 3.5 per cent. for a distance of 100 ft. When the length of slope has to be from 200 to 600 ft., the grade is from 1.5 to 3 per cent., the object being to produce proper velocity.

"The introduction of scales on the slope alters the conditions, for the speed over the scales must be moderate, as already shown, say from three to six miles per hour. If the hump is any higher than is necessary to produce this speed, the car must be checked by the brakes. As cars must be weighed singly, and as the speed must be moderate, the natural place for the scales would seem to be rather near the summit, although an inspection of the table shows that some are quite far away, notably one of the Conway scales, and the two at Chicago, 55th Street. Unless a large number of cars in each train is weighed, the summit does not appear to be a good location, because the weighing is probably done with the car at rest, which would materially delay the rest of the switching. The scale grade should probably not exceed 2.5 per cent. for a distance of 100 ft., and perhaps 2 per cent. for a distance of 50 ft. would be better. There seems to be no good reason for placing the center of the scales farther away from the summit than between 90 and 170 ft. The scale hump may be the only one, as in the case of a coal-weighing yard, or it may be placed alongside the other hump, and on a separate track, for occasional weighing.

"The approach grade to the summit should not exceed that over which the full train can be pushed by one engine.

"Some operating officers request that the top of the hump be level for about 100 ft. If a flat place be not provided, the curve of the top should at least have a pretty long radius.

"To sum up the foregoing, the grade of the classification yard should be about 0.4 per cent., the grade of the ladders from 0.75 to 1.25 per cent. for loaded cars, and from 1.25 to 1.5 per cent. for empties, while, with no scales, the initial grade from the summit should be about 3.5 per cent. for a distance of 100 ft., and 1.5 to 3 per cent. when the slope is longer, but in the case of scales, the initial grade should be 2.5 per cent. for a distance of 100 ft., or 2 per cent. for a distance of 50 ft."

The "hump" may frequently be introduced in an existing yard, with comparatively light business, and effect a considerable saving in operating expense, as well as in securing greater rapidity of car movement. This has been done in a number of instances at a cost of $2,000 or $3,000, and without eliminating any tracks. The elimination, in this way, of the enormous distance travelled by an engine with the old method of "tail switching," and the reduction in damage to equipment and contents of cars usually make the introduction of the hump at any point, a profitable investment. An instance of this kind was the construction of a hump, 6 ft. high at the entrance to the so-called "scale-yard" at the Washington Street terminal of the Lehigh Valley Railroad in Jersey City a few years

ago. This was done without reducing the track capacity and the results have been most gratifying.

In the Oak Island yards of the Lehigh Valley (the outlying or auxiliary yards for the tide-water terminals) a test of the possibilities of the summit switching method was made for the benefit of some visiting operating officers of the Northeastern Railway of England. Two trains, with a total of 153 cars, in 96 "cuts" were classified in 42 minutes, which included the time necessary to go back after the second train some distance away. There were ten classifications maintained throughout. Two cars went wrong on account of inferior hand brakes and were returned. The crew consisted of a conductor, five trainmen and one switch tender. The time actually consumed in pushing the trains over the summit was 13 minutes for the first and 11 minutes for the second; a total of 24 minutes. The records kept show that at Oak Island in handling 253,000 cars the amount of damage done, directly chargeable to the summit grade, was less than $800. It is claimed too, that the damage was more than this prior to starting the use of the summit method, when the yards were worked under the poling method.

Available accurate statistics of the cost of switching by any method are seldom found. The hesitation on the part of operating officers in giving out any information on this subject is readily understood because of the fact that conditions vary to such an extent as to make almost any comparison on a simple cost per car statement practically worthless. So many explanations and qualifying additions must be affixed to any cost statement as to render it useless because of its obscurity, even though we assume that some uniform standard or unit has been reached on which to base the cost. The "number of cars handled" has so many meanings and is figured out in so many ways that it is not always comparable.

In the Pittsburg & Lake Erie yards at McKees Rocks the cost of handling cars over the summit was a fraction over nine cents each. During something over twelve months, there were 253,551 cars in 123,351 cuts run over the eastbound summit at Oak Island, N. J. at a cost of 11.7 cents per car, or 22.1 cents

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per cut for classifying. Of this cost 55 per cent. was for train crew wages; 45 per cent. for fuel, water and supplies.

Mr. Cushing obtained the figures of cost of working in 25 different yards at nine separate periods, in the last 10 years. When these figures include the yard labor only (yardmasters, clerks, conductors, brakemen, switchmen, enginemen, firemen, operators and watchmen) the cost per car handled for terminal yards in large cities, where there is a large distribution of cars to industries (as in Chicago), ranges from 15 to 30 cents; in intermediate yards in cities of good size with a fair amount of distribution to industries (as in Columbus, O.), from 17 to 22 cents; in intermediate yards in small towns and cities which are junction or division points, with but a minor industrial development, from 8 to 20 cents, and yards in villages without industrial development, and which are junction or division points, from 5 to 15 cents.

The manner of operating a yard, whether by gravity or other methods, does not seem to influence the cost so much as the condition of handling it; whether traffic is passing through smoothly or in a sluggish manner.

The accompanying diagrams of a yard for tidewater coal handling and storage plant; a yard for division and tidewater terminal classification and a yard for tidewater freight delivery were prepared by Mr. C. L. Bardo.

The interesting feature in connection with Mr. Bardo's proposed division classification yard is the so-called central ladder. Both of the curves to be turned by the car before reaching its ultimate track are on the lead, and the car that does not run freely is therefore held back and to overcome this and prevent retardation of yard operations a higher grade must be established. It is claimed for the central ladder that this condition will be to a certain extent offset by using the straight ladder for the larger cuts and the other ladder for the single car cuts. An advantage in drainage is apparent, as the ladders are the highest tracks and in the center the water will run away from them and the switches. It is claimed, too, that the ladders being in a direct line, and within the range of the vision of the cutter at all times, he is enabled to work to

better advantage than when his view is cut off at times as with the usual ladder designs. It is also argued that because of the compact location of switches, both ladders lying close alongside each other, the switches may be handled more economically if thrown by hand and, if handled from a tower, a much better view will be afforded and better results obtained. Among other points claimed for the central ladder is economy in crew expense, as trainmen will be available for service on either side of the yard as soon as they reach the central ladder, while under the usual "V"-shaped ladder they are not available for cars going to the opposite side of the yard until they have reached the distributing point at the head of the yard. The open space between the ladders permits locating electric light poles at a point where light is most needed and where it can be supplied with a minimum number of lights, and, where heavy snow storms are encountered, the central ladder possesses advantages on account of its higher location and consequent freedom from drifting.

There is probably no large yard where this central ladder scheme has been tried. It undoubtedly possesses many points of superiority. There seems to be lacking the flexibility by which the "V"-shaped ladder capacity may readily be extended to meet increasing traffic demands. There is some question, too, as to the practicability of the plan to run one-car cuts down one ladder and those of two or more down the other. With the "V" two or more leads may be operated. While it is contended that cars would run more freely because they do not reach the curves until they have attained some headway, on the central ladder arrangement, there is a question whether this would not be more than offset by the additional curvature introduced.

The Pennsylvania yard at Greenville, N. J., is the latest development of an important tidewater terminal on a large scale with the hump method of classifying. The greater part of this work is on submerged land on the New Jersey shore, 3½ miles south of the Pennsylvania Railroad passenger station at Jersey City. The established pier line lies out in New York Bay, about 1.8 miles from the shore. The water frontage is

1,900 ft. and the land frontage along the present shore is 2,600 ft. The distance between the pier line and the bulkhead line is over 4,400 ft.; thus allowing piers to be built over four-fifths of a mile long. The area of the submerged portion is 550 acres, and of the total, the land between the bulkhead line and the shore line amounts to 350 acres. About 8,000,000 yards of material have been put in to raise the level of the submerged land. On the redeemed tract of land west of the bulkhead, has been built the freight terminal.

The eastbound tracks are provided with a gravity mound for classifying, the prevailing grade from the apex to the first switch being 1.0 per cent., falling off to 0.6 per cent. from the last switch to the yard level. This does away with all crossover tracks, thereby greatly facilitating the work of classifying cars.

The new freight yard of the Lake Shore at Elkhart, Ind., was put in operation in the spring of 1904, and is a division terminal, classifying freight in both directions. It was built to relieve congestion at transfer points near Chicago. The Elkhart terminal lies entirely on one side of the passenger tracks. The Lake Shore trains run on the left-hand track. Between the receiving yard and the classification yard in each direction, a summit has been built to facilitate the separating. The total length of this terminal is nearly four miles. The eastbound receiving yard consists of five tracks holding from 88 to 90 cars each. About the middle of the receiving yard is a series of cross-overs to permit of trains being divided up so that each section can be handled separately. The classification yard holds about 836 cars. The eastbound receiving yard has an ascending grade of 0.3 per cent. except near the summit where it increases to 0.85 per cent. From the summit it drops at the rate of 4.3 per cent. for 300 ft. and runs through the switches of the classification yard at 0.6 per cent., continuing at 0.16 per cent. The descending grade of 4.3 per cent. is probably the heaviest used in actual yard practice.

The summit feature may be utilized to feed cars to loading and unloading points, such as coaling stations, large boiler plants for power houses, ash-track conveyors, freight houses,

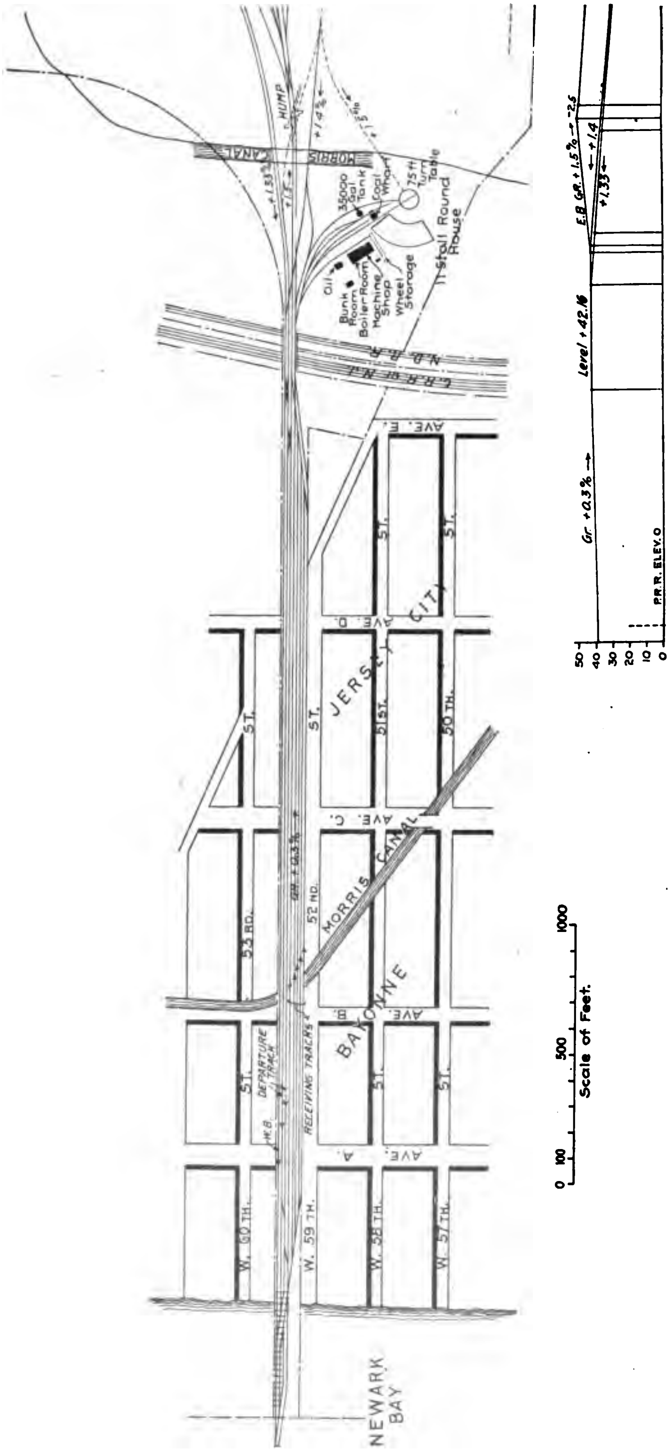


FIG. 32 — Receiving and Departure Tracks and Engine Terminal at West End of Greenville, N. J., Yards, Pennsylvania Railroad.

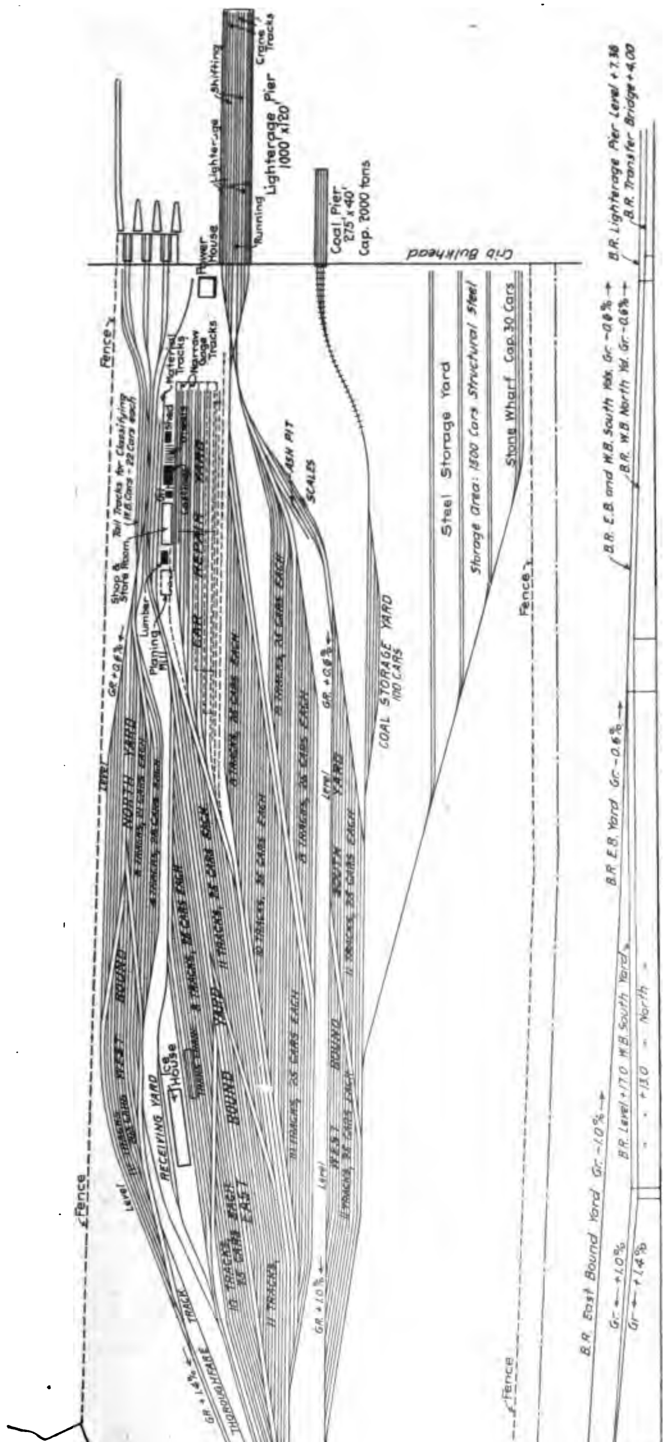


FIG. 33 — Classification and Storage Tracks, East End of Greenville, N. J., Yard, Pennsylvania Railroad.

etc., and this has in many cases effected considerable economies and improved handling generally.

The following is quoted from Mr. Cushing:

"At Columbus, Ohio, the Pennsylvania Lines West had a poling yard assisted by gravity westward, the descent being 1 per cent. It had 8.8 miles of track and handled about 1,100 cars in 24 hours. The yard has been completely remodeled and enlarged. Almost the entire old yard had been taken for a westbound yard. In 1902-1903 the shops, too, were enlarged, and the engine-house rebuilt to care for the larger engines.

"The new yard has 34½ miles of track and will hold 2,800 cars, exclusive of the shop yard tracks. Leonard avenue is near the summit of grades which fall away in both directions, so that the assistance of gravity is obtained for both movements, although the hump is employed in both yards to give the cars their start down the ladders. The westward movement was always by poling assisted by gravity, till in 1902 a knuckle was put in to bunch the cars for uncoupling, and then give them a start down the hill. This did not work well in winter, and the knuckle became a hump in 1904, and was further raised in January, 1905. The summer and winter grades for a hump are quite different, especially in the case of empty cars, and the difference is well illustrated in this yard. The winter grade has worked well during severe weather, but it may have to be reduced in summer to avoid car damage. There is little disposition, however, to cut down a hump, after it has once been made to work well. The new yards have had to handle over 3,000 cars in 24 hours, a statement which gives some idea of the increased business.

"The yard at Sheridan, Pa., was begun in the early days of the 'Pan Handle' by hanging a few tracks on the side of the hill above Cork Run, where the railroad turns sharply to the left from the Ohio river, four miles from Pittsburg, and pierces by a tunnel the projecting spur of the ridge between the Ohio and Chartiers valleys. Step by step the Cork Run valley has been filled up, and tracks laid till the entire space from hill to hill has been occupied by the railroad, except one narrow space for the public road, the run itself passing under the embankment in a large sewer. The valley was originally about 80 ft. deep. The outlet to the Ohio Connecting Railroad was formerly across the main tracks at grade, at 'C K' interlocking station, and many delays were experienced. Therefore, when the third and fourth main tracks were built along the river in 1900-1902, an important improvement was made by putting the Ohio Connecting main tracks underneath the 'Pan Handle' main tracks, and connecting up the Sheridan yard with them so that the coal traffic no longer crosses at grade. This is the yard in which the 'Pan Handle' coal for the Great Lakes is weighed and sorted, as well as the general business for Pittsburg. It is on a continuous 1 per cent. grade descending to the east, but has a knuckle to bunch the cars for uncoupling, and so abolish the old method of poling the cuts, or pushing them with a jerk from the rear. Over 2,000 cars have been handled in it in 24 hours, and ordinarily about 450 cars a day are weighed, though the number has been as high as 685. A large part of the weighing is done in the daytime. The method of switching cars has always been very satisfactory. A train of 35 cars can be put over the hump and sep-

arated into 30 cuts in 25 minutes. The westward movement is handled in the reverse direction, and since it consists principally of empty cars a longer time is required. In another yard, where the method of switching is 'push and pull,' the time required to break up a 35-car train into 15 cuts is one hour and fifteen minutes. The weight of engine used at Sheridan is 169,800 lbs. Interruptions to business, when the scales were being repaired, became so serious that two sets were installed, and are used alternately. The time has come for using all of this yard for the Pittsburg city business, and it was necessary to seek another site for the coal-weighing yard. The new yard site was found at Scully, back of Sheridan, in the Chartiers valley, and a double-track railroad line has been built around the hill to the location, and connecting the main line at Carnegie with the Ohio Connecting road at Sheridan. It was not an inviting place to choose for a yard, but was the only available spot left. It is about 41 ft. from the rail on the hump to the original ground surface. The present development has about 24 miles of track, or standing room for 1,740 cars, and is principally for eastward business, as the westward traffic will be empty coal cars which will require but little sorting. The large number of receiving tracks, eight, in proportion to the number of classification tracks, fourteen, is noteworthy. A departure yard is supplied, to be used principally when the classification work is pressing. The classification yard is built with the center ladders, advocated by Mr. Bardo, but the plan was made in 1903, a long while before his paper was read before the New York Railroad Club. A twin-scale, as at Sheridan, has been built. An investigation into the proper rate of speed for cars, when being weighed, to pass over a scale, was recently made, and it was found that the right speed for accurate weighing lies somewhere between three and six miles per hour, according to the skill of the weighman. At four miles per hour over a 46-ft. scale the rate is equal to about six cars per minute, and at five miles per hour to about eight cars per minute. As many as ten per minute have been weighed by a skilled weighman. A very complete installation of electric lights is being made.

"At Alexandria, Va., the yard of the Washington Southern Railway is by no means small, having a standing capacity for about 3,127 cars, while ample provision for future growth has been made. There are receiving, classification, and departure yards for each direction of traffic, repair, storage, and cabin car tracks, and a transfer station 800 ft. long, besides the engine yard, which is considered a model type. The receiving tracks are from 45 to 60 cars long, and separate receiving and classification tracks are provided for the fast fruit and vegetable expresses from the south. The southbound classification yard has 21 tracks, varying in capacity from 25 to 50 cars each, while the departure tracks will each hold 50 cars. There is also an icing station not far from these yards. The switching will be by gravity with the assistance of humps, the maximum grade on which is 2½ per cent.

"When a yard has reached its economical and practicable limit in size, it is advantageous to consider building a series of yards. It is exceedingly difficult, and, perhaps, impossible to define the limit in size of freight yards because so much depends upon the proper arrangement of tracks. The experience of the Pennsylvania Railroad at Harrisburg is instructive and an actual test of con-

ditions. At Harrisburg there is a series of yards containing 109 miles of tracks, which have grown till they have a standing capacity for 10,000 cars, and were operated until recently by poling. One eastward and one westward hump have been built in the last few years, but poling is still used in the other yards. The largest unit is No. 4, the westward hump yard, having 11 receiving tracks, and 30 classification tracks. No. 3 westward has 7 receiving and 12 classification, while No. 2 westward has 8 tracks. No. 1, the largest eastward unit, is a poling yard where two engines are used, and has 8 receiving, 21 classification and 9 solid-train tracks. The eastward hump yard is No. 5 with 10 receiving and 10 classification tracks. Some of the tracks above enumerated are very long, holding 135 cars. The average time for breaking up by poling an eastward train of 80 cars is 50 minutes, while a westward train of 100 cars can be broken up into 50 cuts over the hump in 35 minutes. A train can be pushed over the hump in 9 minutes, or at the rate of 6 cuts of 2 cars each every minute. A consolidation engine weighing 193,500 lbs. can push 130 cars over the hump as long as the temperature does not drop below 25 deg. above zero, but below that point it requires two engines coupled. The magnitude of the business is appreciated when it is known that 72 trains with 3,750 cars have been despatched eastward, and 66 trains with 3,644 cars westward in 24 hours.

"The Conway yard of the Pittsburg, Fort Wayne & Chicago near Pittsburg bears a close resemblance to Harrisburg, except that all switching is now done over summits. It is also a collection of units and is now being enlarged. When completed there will be three units for westward business and two for eastward, with a liberal departure yard at each end, having tracks of from 65 to 90 cars capacity. The largest number of tracks in any classification yard is 30 eastward, at 30 cars each, and 23 westward at 45 to 80 cars each, the total standing capacity being 8,967 cars. The daily business handled is very large, being about 2,300 cars, while a maximum of 2,638 has been reached. Under good working conditions an 80-car train can be broken up over the hump into 60 cuts in about one hour, while by the old method of drilling three hours were required. It must be borne in mind, too, that the cars are weighed just as they come in the train, while formerly the weigh cars were cut out and weighed separately. Every conceivable kind of freight, iron ore, merchandise, stone, sand, sewer pipe, grain and a large number of empty coal and coke cars eastwardly, and coal, coke, merchandise and minerals, westwardly, are handled in the yards. The humps work well, except in the case of empty cars, due to the poor arrangement of the old ladders, and the consequent long distance the cars have to run, the result of gradual growth for many years. The experience emphasizes the desirability of well-designed ladders. With long ladders, high humps and heavy grades are necessary. Two consolidation engines each weighing 174,300 lbs. are required to push trains over the humps.

"The Enola yard at Fairview, which is designed to relieve Harrisburg, is larger, having standing room for about 10,705 cars. It has been described and illustrated in the *Railroad Gazette,* April 15, 1904, but some of the important features will be touched upon in connection with the limit in size of yards. The engine yard is laid out in accordance with the typical design of the Pennsylvania, already mentioned in connection with Alexandria, and is in the center of the collection

of yards, which has come to be regarded as the correct location, since it was first adopted for Conway several years ago. The water supply is furnished from large storage reservoirs on the hill above, an important departure for railroads. The westward receiving yard has 20 tracks of 90 cars capacity each, and the classification yard 25 tracks of 110 cars capacity each. The eastward receiving yard has 21 tracks of 90 cars each, and the classification yard 17 tracks of 70 cars each, while there are six tracks of 70 cars each for solid trains. The large number of receiving tracks in proportion to the number of sorting tracks is noticeable. The arrangement of ladders for the classification yards is among the best used anywhere. The large V arrangement of the hump end of the yards is made up of two small V's, and each has its track over the hump and one around it. These are, therefore, two separate yards which can be worked by two engines side by side. The beautiful regularity of the ladders is to be commended. There is also a free track alongside the ladder to be used by an engine for poling in derelicts when necessary.

"At Logansport, Ind., the standing capacity of the yard is 2,124 cars. The average business handled is 2,000 cars a day, and the maximum 2,821 cars. In ordinary weather it requires from 20 to 25 minutes to break up a train of 85 cars over the hump, and in zero weather about 50 minutes. An engine weighing 174,200 lbs. is used for the west hump (built in 1900), and one weighing 193,500 lbs. for the east one (built in 1902).

"The westward hump at Crestline on the Pittsburg, Fort Wayne & Chicago has been one of the most satisfactory on the Pennsylvania system, due to the moderate size, good arrangement of ladders, grade of yard, and character of business, consisting of loaded cars of coal, coke, other minerals, merchandise and some empty box, stock and refrigerator cars. There is a standing capacity for 1,874 cars, in both yards, and the daily business is about 1,100 cars, the maximum being 1,330. Under good working conditions, it takes a consolidation engine weighing 124,800 lbs. about 10 or 12 minutes to dispose of a train of 35 cars into 18 cuts over the hump. The switches are handled by mechanical levers in a tower nearby.

"The westward summit at Bradford has been about the longest in service on the P., C., C. & St. L., having been built in 1900. It works well under ordinary conditions, but has not given satisfaction during severe weather. A considerable number of empty box, stock and refrigerator cars are passed over it. The business amounts to about 1,000 cars, but runs up to 1,800 or 1,900 at times. The standing capacity of both yards is 1,715 cars, but it is soon to be enlarged.

"The westward hump at Richmond Junction was built in the same year, 1900. The main part of the yard is not on sufficient grade, 0.25 per cent., for winter work, so that it will be necessary to raise the hump. The standing capacity is about 745 cars, and the daily business about 800 cars.

"The Mansfield, Ohio, yard is a new one, built in 1904, the eastward hump having been put in service in December, and it has given the utmost satisfaction since. The westward one was put in service in February, 1905. The character of the business is merchandise and a large number of empty coal cars eastward, and merchandise, coal, and a few empties westward. The standing capacity is 630 cars and the

average daily business is about 700 cars. Richmond, Bradford and Mansfield are junction-point yards.

"The Linwood yard near Cincinnati was also built in 1904, and is for westward business only, which amounts to 400 cars daily. The standing capacity is 656 cars, and the hump working is very satisfactory. A 30-car train can be classified in 35 to 40 minutes."

A very interesting use of the hump switching method is its facility for a ready, quick and most practical inspection of the rolling resistance of cars. An inspector should determine, after a little experience in observing the movement of cars over a hump, whether the resistance due to bad design or condition is such as to warrant cutting it out for repairs or rejecting it. There is a great difference in the drawbar pull necessary to move cars. It would seem proper to forward only such cars as are in condition to enable the locomotive to draw its rated tonnage at an economical point of cut-off. Cars with excessive resistance should be withdrawn from service. There is no better place to locate such cars than on the classification yard side of a hump. An inspector can easily identify loaded, lightly loaded, and empty cars which are unnecessarily hard to draw in a train. It would seem to be one of the easiest places to detect cases of badly cut journals, badly fitting brasses, heated bearings, excessive weight on side bearings, and other causes that increase the resistance.

CHAPTER XII

Gravity Switching

There are so many conditions governing terminal switching that an actual case of switching by continued gravity alone is not in use where winter weather is severe. There are many yards in which cars are dropped into the tracks of a separating or classification yard during many months of the year by gravity, without the assistance of poling, a summit, or "kicking." Except in the mild climates, however, where extremes of low temperature are infrequent, it is probably not practicable to construct a gravity yard that can be successfully operated as such with all kinds of cars and loads during twelve months of the year. If the grade is sufficiently heavy to start a car during very cold weather, the speed attained on such a grade during warm weather will be excessive and, on the other hand, if the grade is right to permit of safe handling during summer there will be times, during winter, when cars will not start and the assistance of an engine becomes necessary to move them.

A terminal worked by gravity solely, during the greater part of the year may, for all practical purposes, be properly termed a gravity yard, which is one wherein a car, or a number of cars, coupled, will start on releasing the brakes. To accomplish this, grades from 0.8 to 1.0 per cent. are necessary. In many instances even 1.0 per cent. grade will not be sufficient to start a car, as for instance, when the journals and packing in the boxes have become thoroughly chilled or when the opposite extreme, an excessively hot box exists, or has recently existed.

With the use of much lighter and smaller cars, and an arrangement whereby brakemen can apply brakes from the side, gravity switching is in more general and satisfactory use in Europe than in America. There they also use "shoes" to assist in stopping cars. These are chocks made to fit over the rails in such a manner as to force the car wheels to run

up the inclined upper side of the shoe, from which they roll back again, releasing the shoe. " Chain drags " are used too, to catch runaway cars. This is a large heavy chain located in the track in such a way that a switchman by throwing a lever causes the hook at one end of the chain to engage with an axle under the car and the dragging of the chain gradually brings the car to a standstill.

It is apparent that the first cost of a gravity yard is prohibitive unless the lay-of-the-land happens to be quite nearly adapted to it naturally. In 1873 the Edge Hill yard at Liverpool, England, was designed and the work of construction begun. This yard is still considered one of the best designs of a terminal known for the prompt and economical distribution of cars. The Edge Hill yard, on the London & Northwestern Railway is commonly believed to be the first yard of any importance constructed on the so-called " gridiron " plan for classifying cars by gravity. It is also generally assumed that it was the first to use an advanced method of switching on a large scale and to abandon the old " push and pull " or " link-and-pin " process, for classifying cars. It was not unduly costly, for Nature had shaped its topography in a wonderful way at the precise spot where the yard was needed.

A gravity yard was put in operation in 1894 at Dresden, Germany, and is remarkable for its high cost of construction. At the upper end a fill 70 ft. high was necessary. From an operating standpoint this yard proved very satisfactory. It is about one and a half miles long and half a mile wide. This Dresden yard is probably the one in which the first gravity switching was done in Germany.

In the Perth Amboy, N. J., coal terminal of the Pennsylvania, cars are classified by gravity switching for the greater part of the year. The author has frequently watched the operations in this yard, and has been impressed with the ease with which trains are broken up. There are two points that tend to make gravity operation successful at Perth Amboy. The winter weather is not accompanied by exceptionally low temperature and the commodity handled is coal.

The effects of different rates of grade on trains of dif-

ferent lengths, is interesting, and in connection with gravity switching, it may be well to consider both the theoretical and practical determination of the necessary gradient. The "grade of repose" is just a little short of the rate of descent necessary to start cars when the brakes are released. Mr. A. M. Wellington studied the general effect of the rate of "rise and fall" thoroughly and says:

"The grade which produces a longitudinal force precisely equivalent in pounds per ton (or any other unit) to the 'rolling friction' of the car at any given velocity, is called the 'grade of repose' for that velocity, being that grade on which, if a car or train were descending, the accelerating force of gravity would just balance the resistance to motion, and hence enable it to continue in motion forever at the same speed, neither gaining nor losing velocity, which is the theoretical condition of all bodies to which a given velocity has once been communicated, according to Newton's first law of motion.

"As the frictional resistance per ton varies with either the velocity or the length of train, the 'grade of repose' will also vary with either. These grades, as determined, are given in the following tables:

TABLE A

Approximate Grades of Repose for Various Trains

Velocity. Miles per hour.	Frt. train of 20 cars.	Frt. train of 50 cars.	Pass. train of 4 cars.	Pass. train of 12 cars.	Approximate General Avg. Grade per cent.	Feet per mile.
10	0.30	0.28	0.34	0.27	0.30	16.84
15	0.36	0.33	0.40	0.34	0.35	19.48
20	0.46	0.40	0.52	0.42	0.40	21.12
25	0.58	0.48	0.69	0.53	0.50	26.40
30	0.73	0.59	0.88	0.65	0.65	36.32
40	1.00	0.90	1.38	0.98	1.00	52.80
50	....	....	2.02	1.39	1.50	79.20
60	....	....	2.81	1.89	2.25	118.80
70	....	....	3.74	2.49	3.00	168.40

(The resistance in pounds per ton is given by multiplying the above by 20.)

TABLE B

Grades of Repose for Passenger Trains of Various Lengths at Various Speeds

(17-in. × 24-in. American Engines — Cars Averaging 25 Tons each)

Kind of train.	Weight. Tons.	Grades of repose, per cent. for velocities in miles per hour. 15	20	25	30	40	50	60	70
Engines only.	56	0.60	0.88	1.24	1.69	2.81	4.25	6.03	8.12
Eng. & 2 Cars	112	0.45	0.62	0.83	1.08	1.74	2.58	3.62	4.83
4	168	0.40	0.52	0.69	0.88	1.38	2.02	2.81	3.74
8	280	0.36	0.46	0.58	0.73	1.10	1.58	2.12	2.87
12	392	0.34	0.42	0.53	0.65	0.98	1.39	1.89	2.49
16	504	0.33	0.41	0.50	0.62	0.91	1.28	1.74	2.28

Table C

Increase of Grade which will be Compensated for by a Reduction of Train Speed from Each of those Given in Preceding Table to the Next Lower

Kind of train.	Reduction of equivalent grade by reducing speed from — 20-15	25-20	30-25	40-30	50-40	60-50	70-60
Engine only	0.28	0.46	0.45	1.12	1.45	1.77	2.09
Engine and 2 Cars	0.17	0.21	0.25	0.66	0.84	1.04	1.21
4	0.13	0.16	0.19	0.50	0.65	0.78	0.93
8	0.10	0.12	0.15	0.37	0.48	0.54	0.75
12	0.08	0.11	0.12	0.33	0.41	0.50	0.60
16	0.08	0.09	0.12	0.29	0.37	0.46	0.54

"Note. — While it is probable that these differences represent somewhat more than the actual differences in the resistance to be overcome, it is quite certain that they are not nearly large enough to fully represent the combined effect of the lower resistance and greater cylinder and boiler power of the engine at lower speeds.

"The term 'Grade of Repose' is ill-chosen, and originated in the mistaken idea that a grade which was heavy enough to more than equal the resistance of motion when a train was once moving, was heavy enough to start a train from a state of rest. In reality a grade several times heavier is necessary and this latter only can properly be called a 'grade of repose.' But the ill-chosen term is still the common one, as is likewise, unhappily, the erroneous idea in which it originated. Otherwise, probably, there would be fewer stations on limiting grades.

"When a railroad train descending a grade, or any other falling body is acted upon by an accelerating force which remains uniform, like the traction of a locomotive, or gravity, in opposition to a retarding force which increases with the velocity, like the resistance of a train, the velocity of motion will continue to increase until the retarding force becomes equal to the accelerating force and thereafter the body will continue in motion indefinitely at a uniform velocity. The net resultant of all the forces acting is then zero, and consequently the body continues indefinitely in motion at an unvarying velocity, as theory requires.

"This statement should be read over until its meaning is fully grasped. A railroad train in motion at a uniform velocity is acted on, in one sense, by two forces, but in a true sense by no force. The frictional and other resistances and the traction of the locomotive act upon and destroy each other within the body without either acting upon the body itself, except to produce internal stress. Such a body is therefore one of the nearest examples in practical mechanics of Newton's abstract conception of a body moving on indefinitely *in vacuo* from original impulse, without gain or loss of energy, as do the heavenly bodies.

"Under such conditions *any new force,* whether accelerating or retarding, like a change in the rate of grade or in tractive force of the locomotive will act upon the body precisely as if no other forces existed to act upon it; *i. e.,* the *whole* of the new force, undiminished by frictional or other losses, will act upon the body to vary its velocity, and will vary it precisely as theory requires. This fact bears with it important consequences."

In yard design and operation, train resistance plays an important part and before leaving this subject it may be well

to call attention to the fact that Wellington recommended the formula of William H. Searles as the basis for all train resistance computations. Although many years have elapsed, the same recommendation seems to hold good. The Searles formula consists of a single simple equation closely approximating what experiment indicated to be the ordinary maximum for the resistance of trains of all classes, at all speeds, and with all forms and weights of cars. Searles' claim is that:

"It is an empirical formula, based upon a careful investigation of all such records of experiments on the subject, several hundred in number, as have come under the author's notice, and is believed to give results agreeing closely with the average experience and practice of the present day. It is designed to give the resistances per ton for all trains, whether freight or passenger, and at any velocity, under ordinary circumstances. Accidental circumstances, such as the state of the weather, and the condition of the road bed, rails and rolling stock, may largely modify the resistance, but these, of course, are not taken account of in the formula."

The formula in simplified form is as follows for velocities in miles per hour:

Average resistance of entire train in pounds per ton of 2,240 pounds for all weights in gross tons,

$$R = 5.4 + 0.006V^2 + \frac{0.0006\ V^2\,(\text{wt. eng. and tender})^2}{\text{gross wt. of train}}$$

Average resistance of entire train in pounds per net ton, for all weights in net tons,

$$R = 4.82 + 0.005357\ V^2 + \frac{0.0004783\ V^2\,(\text{wt. eng. and tender})^2}{\text{gross wt. of train}}$$

Searles' formula does not take into account the difference in weight of light and heavily loaded cars, and in this seems to be defective. In comparing with a large number of tests, however, the formula seems surprisingly accurate. The author during the past ten or twelve years, has applied it to a large number of test runs, and compared it with figures of train rating based on good all-round practice and has found the variations to be comparatively insignificant.

CHAPTER XIII

Records

To satisfactorily operate a terminal it is essential that records of all movements be kept. These reports and records are not altogether for the purpose of answering questions asked by those at a distance relative to movement or location of certain cars. They are primarily to enable the yardmaster or other operating officer in charge of the terminal to inform himself at any time as to the general situation. It is apparent on many roads that the report and record business — and especially the report — is overdone. This seems to be due to an increasing demand for information and the closer tracing of freight by shippers and traffic officers. The easy abuse follows, by which department heads and officers ask for another report by wire, or mail, or both, weekly, daily and oftimes at several specified times daily. The result is to demoralize and confuse the organization and overload the local forces with a mass of detail apparently serving no good end. It prevents the local operating head from receiving the information he needs in his business. As he cannot secure a considerable increase in clerical and other forces, without being able to show a corresponding increase in traffic to justify it, the business of the terminal suffers. All the information asked for in the special and additional reports is usually already made up and sent in, in some form or other, but is perhaps not readily and conveniently abstracted, or is not known to be at hand by the clerk in charge. In any event it seems easier to wire the superintendent or yardmaster for it. When such additional demands for information are made, a general revision of the entire system of reports, cutting out five or six that are going in and substituting one or two simplified forms, will in many cases accomplish the desired result and enable a reduction of clerical work at the terminal, instead of necessitating an increased force. It will also enable the superin-

tendent to get more result-producing work out of his subordinates. When that ideal condition is reached in a terminal where no questions need be asked, special reports will not be needed.

An unfortunate condition exists in the transportation department of some railroads where the operating head has not the time necessary to watch such details as yard or train reports and is dependent largely, if not wholly, on a chief clerk or other subordinate officer. The latter is, what is termed in railroad parlance, an "office man"; that is to say one who has got his railroad knowledge in an office and has therefore, little practical or actual experience. As a natural result, when he wants anything he asks "somebody" for it. Had he in times past worked as, or with, a switchman, a yard-conductor or a yardmaster he would probably know that the information desired was already being received in some form. It may be, too, that the chief clerk is a "six o'clock man."

The author knows of instances where reports requiring many hours' work, were sent in daily by yardmasters, trainmasters and superintendents, which had not been needed or used in years. When the discovery was accidentally made, the explanation followed that there had been a time once when the information was required.

A system of reports or blanks is usually prepared by a clerk who is expert in that kind of work. He makes an estimate as to how long it will take him to make out each report. He may not take into consideration the fact that what he with his special training can accomplish in eight or ten minutes in his office at a desk with ample light, ventilation and heat, may take a yardmaster or other outside employee five or ten times as long.

In one office, the author was shown an elaborate report of engine movements at terminals. It required records to be kept by eight different persons, and these were consolidated on one blank before being sent in. It was a fine production. A superintendent could easily put in two or three hours daily in getting unnecessary lessons from it. Many reports are made and pigeon-holed because they may be

needed "some day." Somebody is paying for them in the meantime.

In a large terminal, a yard engine was assigned to a district and its work was usually behind. The work done was analyzed and it did not seem sufficient to justify the use of more than one engine. The conductor spent about two hours a day working on "reports" and while he was an exceptionally good yard-conductor, he had neither the ability to successfully plan work for others or to take a prize as a rapid recorder and report-maker. Moreover, the greater part of his reporting was of cars moving from one point in his district to another, the car service office having at some time in the past asked for this information. There being apparently no use made of this information, he was told to discontinue sending in this report. There were no further complaints of work not being done in that district, and years passed without any one in the car service office discovering the discontinuance of the "interior" car movement report.

The author has frequently watched a freight conductor making out his switch-list, while riding on the cupola of a four-wheel caboose, rounding the curves, and bracing for the running in and out of the slack in the 80 or 90 cars ahead. With 50 or 60 of the cars air-braked, this feat requires agility. An oil lamp, tucked under the conductor's arm, gave all the light to be had and further embarrassed him in endeavoring to comply with the printed instructions, "write figures legibly." To put down 80 numbers of five figures each, about 400 in all, under such conditions, in a space so small that they could hardly be inserted by one of the "Lord's Prayer on a dime" experts, and adding the initials of the cars, the designation for "loaded" or "empty," giving the contents, kind of car, originating point, road's destination, final destination and in many cases, the record of seals on each side of each car and on end door, must of necessity take up some of the conductor's time. Clerks should do as much of this kind of work as possible. These road and yard men are not chosen for their book-keeping ability.

One of the first essentials, and doubtless the most impor-

tant, is to keep records by which one can intelligently and with reasonable accuracy determine the cost of handling a terminal, adopting some unit as a basis, for comparison with other terminals and for comparison with itself during a previous period. That both comparisons are beset with difficulties is apparent. Many factors enter into the computation and allowances have to be made for weather conditions, changes in character and volume of traffic, increased or decreased number of cars or tons for private sidings, or warehouses where work is attended with extraordinary difficulties, change in power used, kind of fuel, amount of passenger work, revision of loading and transfers, etc.

The unit of cars handled is probably the only practical one. In this, however, the figures may be manipulated to mislead. Every movement of a car may be counted, in one case, and only arrival at and departure from terminal in another. In the former it may count as ten, or even more, and in the latter as two. What constitutes a car movement, or a car handled must first be determined.

For the reasons already outlined, the basis of computation, cars handled, is about as unsatisfactory for the purpose intended, as it is possible to make it. It is, nevertheless, the one used more often than any other. The yardmaster's desire to make a good showing for himself and his yard by reducing the cost per car handled will induce him to run up the number of cars handled to the highest figure.

The author at one time had charge of a large marine terminal yard, and had reduced the cost of handling to what he considered a fair figure, and included every car movement in the number of cars handled that he conscientiously considered right and fair. An interior yard of very much smaller size and lighter business showed a decidedly lower cost to the surprise of every one. Inquiry developed that the smaller yard showed a much greater number of cars handled than did the larger yard. Knowing that this was not the actual condition, the author spent several days in the interior yard and analyzed its methods. The business actually done did not compare with that of the marine terminal, but every movement or apology

for a movement was recorded and reported. A record was kept of a car moving from the general yard to the transfer platform; from the transfer to the freight house; from freight house back to transfer and again back to outgoing yard. Aside from the manifest unfairness of the method, the amount of time spent on these reports should be considered. This was done by men not trained or intended for that kind of work, and all of it was absolutely useless. This instance in practice will illustrate the futility of using the present general methods of accounting in yard work, for the purpose of making comparisons between yards, unless an understanding is first arrived at.

An excellent plan has been advanced — and it was many years ahead of the times when actually tried — in the determination of units in yard work and basing thereon a standard for comparison, every item of work and cost being analyzed and separated. This was, at the time commonly known as the "standard unit" method. The actual performance for a period of months or years back was taken and from it a statement was made dividing up all the principal items of work done, and the cost. This basis was used as the standard with which comparisons of following months were made and increases or decreases explained. Some of the items to be enumerated are: —

1. Cars received and forwarded in trains.
2. Cars delivered to and received from connecting lines.
3. Cars delivered to and received from private industries.
4. Cars to and from freight house and team tracks.
5. Cars to and from coal chute tracks.
6. Cars to and from transfer tracks.
7. Cars weighed.

The total of these items would represent the number of "cars handled" and it is necessarily many times greater than the actual number of cars involved in the computation.

For illustration, let it be assumed that there were handled, the first month, a total of 7,000 cars and the same number the second month; with the exception that the second month there were fewer cars handled in certain movements and more in

others. Using the item numbers in the list of movements just given: —

Items.	First month.	Second month.
1	1,000	500
2	1,000	500
3	1,000	1,000
4	1,000	1,000
5	1,000	1,000
6	1,000	1,500
7	1,000	1,500
Total	7,000	7,000

To apply the "standard unit" method, it is first necessary to fix a value for each item. A movement may become more difficult and expensive. An industry may change its track connections or may change the method of loading or routing of cars requiring less "spotting" of such cars when being placed. The movement may be made less difficult and expensive. Approaches to a coal chute may have a reduced grade or improved track connections enabling a locomotive to put up more cars than formerly. It is therefore desirable from time to time to revise the standard.

Assuming item No. 1 to be the simplest, the value may be placed at 1. Item No. 2 may be no more difficult than item No. 1 and would be given the same value. Items Nos. 3, 4 and 5 each require three times the work of item No. 1 and would be placed at 3. Items Nos. 6 and 7 may each require twice the work of item No. 1, and their values would be placed at 2. Taking the case where 1,000 movements were made in the first month under each head gives the following number of units: —

Items.	Cars handled.	Value of each.	Total units.
1	1,000	1	1,000
2	1,000	1	1,000
3	1,000	3	3,000
4	1,000	3	3,000
5	1,000	3	3,000
6	1,000	2	2,000
7	1,000	2	2,000
Total	7,000		15,000

Dividing the 15,000 units into the total cost of handling the terminal for the month, gives the cost per unit for purposes of comparison. Applying the unit basis to the month

following in which the total number of cars handled was the same but varies as between the items:

Items.	Cars handled.	Standard values.	Total units.
1	500	1	500
2	500	1	500
3	1,000	3	3,000
4	1,000	3	3,000
5	1,000	3	3,000
6	1,500	2	3,000
7	1,500	2	3,000
Totals	7,000		16,000

While the number of cars handled is the same in each month there were 1,000 more units of work performed and with an increased total cost of handling of 6⅔ per cent., the cost per unit would be the same. If the standard of values has been correctly assessed this would approximate actual conditions. The author used this system very successfully and satisfactorily in a large and busy terminal.

In some terminals the whole computation has been made on the basis of number of cars received and forwarded in trains and cars delivered to and received from connecting lines. This is not worth while. In other terminals the calculations of cost are based on the number of cars in and out in trains, and cars switched for revenue. Aside from the futility of so comparing the yard work done on one road with another, there is probably little use in endeavoring to bring about a satisfactory comparison between any two yards on the same road. There is no good reason why the "standard unit" system cannot be satisfactorily used for several or all yards, and the general officers of the transportation department could have figures showing the operating cost of the different yards that would mean something.

Under the system of assessing values to units of yard work in each yard, it is necessary, to enable comparison between two or more terminals to be made, that the value of the units be made uniform throughout. To secure uniformity of values a committee might be appointed to fix the value of each unit in the different terminals. It would be well to have a representative from each important terminal on this committee and three or more general transportation officers to act as

arbitrators. After the values are once fixed they would not need to be disturbed until some change in conditions necessitated a local adjustment. This method is not intended to apply to the figures given and records kept of the cost of classifying cars in terminals, by summit, poling, or gravity methods. There are no great complications in this and the figures are full of meaning and of the greatest value.

The contract or so-called "piece-work" system would seem a most satisfactory one to use in classifying yards worked by either summit, stake or gravity methods. It is not difficult to estimate the cost per car and the men under their foreman, as a sub-contractor, should be paid on that basis at the end of the month or week. This would tend to do away with labor troubles, the necessity for supervision and paying overtime, and would under the law of the "survival of the fittest" weed out the sloth and drone. Damage to cars might be expected to be reduced, as a derailment or accident obstructing the work would cause the men to be idle and lose pay.

A simple, intelligent, accurate, reliable, and closely followed up car record is essential in any yard of even moderate proportions. The usual error made in adopting a record in yards that have been operated without any records is to record more than is absolutely essential. The record should give just such information as is needed in the particular terminal in which it is installed, and no more. The per diem method of paying for the use of cars has made records necessary where they were not needed before and has extended those already in use. The movement of cars in and out, on each of the various divisions and connecting lines involved, whether loaded or empty, cars to and from shops, freight houses, etc., are necessary in a car record at the average division terminal.

One of the simplest and most economical records is that using the ending or terminal figure of the car, and where nothing more is required, it is decidedly the best. This is usually kept on large loose sheets divided into 10 squares each, the last figures across the sheet and the second and third figures up and down making it necessary to write only the figures in advance of the three last ones in each number. As men

become accustomed to it they can fill in the numbers very rapidly. One man should easily enter up 2,500 car numbers a day besides replying to telegraphic and telephone inquiries as to cars. The date is entered, abbreviations for divisions, connections, etc., by using letters A, B, C, etc., and the symbols X for loaded and — for empty. The X or — is placed ahead of the number when it indicates "arrival"; and after the number when it indicates "departure."

A simple form of report is one on which each sheet is divided into ten squares, numbered 0, 1, etc., to 9, inclusive. The car numbers are entered in full, and all those ending in the figure 1 in the space headed 1, etc.; in this record it is only necessary to look up one-tenth of the entire lot of numbers when one is wanted.

The following represents a part of the so-called "terminal number record:"

Numbers of.................. Cars..................

Below 1000										1,000										2,000						
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6
						24																				
9,000										10,000										11,000						
													32					57								

There are nine squares across the sheet and ten vertically, the heading of the last square, the lower right-hand corner, reading 89,000. In practice, a sheet is usually used for the movements in each direction daily, although it is customary in some yards to use a sheet for each period of eight hours, thereby getting a close approximation to the time of day. In the figures above cars 624, 10,332 and 10,857 are entered.

Another simple form of record, useful only in small terminals, is that of having each conductor, on arrival, bring in a list of cars and having a yard clerk note the departure opposite the numbers of the cars as they move out. These

lists are deposited in a pigeonhole in a large case having a compartment for every day in the month.

An elaborate record is sometimes kept in which no part of the car number itself needs to be written. A book of 100 double pages with 10 horizontal divisions across the page and 100 lines vertically is used. Car 18,945, for instance is entered on page 45 in horizontal division 9 and on line 18. The owning road's initials or its customary abbreviations are entered with the indications for load, empty, date (occasionally time) of arrival or departure, etc.

The use of a certain colored ink for cars arriving between midnight and 8 A. M.; another for those between 8 A. M. and 4 P. M. and another between 4 P. M. and midnight is followed at some points, to give a pretty close line on the time of arrival. One of the objections to this form of record is the large amount of leafing of the books, making it difficult to bind them substantially enough to last through their ordinary period of service.

One of the best car record books for a terminal is made up on the plan shown on the following page:

This record may be handled with three columns, instead of four, to each division, but it may be desirable to show time or other information, such as further movements, in which case the additional column may be needed. In the sample record shown the page is numbered "01." The pages run from "00" to "99" or upwards. When they stop at 99 the book provides for any number to and including 99,999. The cars entered on the sample page given are 37,001, 27,101, 2,301, 85,401 and 27,701.

To more fully explain the working of this record the cipher used is as follows:

X	Loaded car.
—	Empty car.
A	Baltimore Division.
B	Omaha Division.
C	Boston Branch.
D	K. & A. connecting road.
E	Freight transfer platform.
F	Shops.

When the symbol X or — is placed before the cipher letter it indicates that the car was received; when it is placed

Page No. 01. Record of Cars at-----------------------------------190----

0			1			2			3			4		
Car	Rec	Fwd	Car	Rec	Fwd	Car	Rec	Fwd	Car	Rec	Fwd	Car	Rec	Fwd
L & N 37	X A 9/1		LEW 27	X A 9/1	B X 9/1				G T 2	X B 9/1	C X 9/2	So 85	—C 9/4	E— 9/5

5			6			7			8			9		
						I C 27	X F 9/4	A X 9/4						

Sample Page of Car Record Book.

behind the cipher letter it indicates that the car was forwarded. Abbreviations or symbols are frequently used for the initials of cars belonging to foreign roads most frequently handled. In many records no attempt is made to abbreviate road initials. No initials are entered for system cars and it is customary to enter them in a separate book.

In the record shown, car L. & N. 37,001 was received loaded from the Baltimore Division on Sept. 1. The entry is made on page 01 (the last two figures) in section 0, thus: $\frac{\text{L \& N}}{37}$ XA 9/1 as indicated on the portion of sample page shown. This entry indicates too, that there has apparently been no further or outward movement of this car. Other entries made show: L. E. & W. 27,101 received from Baltimore Division loaded Sept. 1 and forwarded by Omaha Division loaded Sept. 1; G. T. 2,301 received loaded Sept. 1 from Omaha Division and forwarded by Boston Branch loaded, Sept. 2; So. 85,401 received empty from Boston Branch Sept. 4 and forwarded empty to the freight transfer platform; I. C. 27,701 received loaded from shops Sept. 4 and forwarded loaded to Baltimore Division Sept. 4.

The record kept by the New York Central at West Albany, N. Y. is a practical ready reference book, and economical to keep up. Through the West Albany yards, 32,782 eastbound and 35,140 westbound, a total of 67,922 cars, were passed during January, 1905, necessitating 135,844 entries, to cover "in and out" movements, besides the additional entries to cover two for each car sent out to transfer house, two for each car sent to shops, etc. The work is done by four men.

Figures 34 and 35 show a part of a page of the record book. These books are paged consecutively from 1 to 1,000, the two pages facing each other having the same numbers. These two pages have entry lines for each 100 cars so that a set of books will take care of 100,000 car numbers. The car record is made as follows: Suppose the number is 62,175, the entry is made in line 75, of page 621. Each line is doubled and has space for eight car entries, which allows for duplicate entries of the same numbers, whether they belong to a home car often

arrangement and should be adopted in all yards with sufficiently heavy traffic movement to justify it.

A system of checking car movements by the use of cards especially prepared is interesting, and while it is in no sense a substitute for a regular car record, is worth some study because of the good features it possesses. A case is used containing 100 pigeonholes labeled 0, 1, 2, etc., to and including 9 across and the same vertically. After a train has been entered up, a card is made for each car giving initial, number, date received, reference to page of entry, date outbound, engine, train, time, contents and destination. The ticket for each car is then placed in its proper pigeonhole. Car 43,228, for instance, would be placed in pigeonhole in row 2 (from top) and across in vertical row 8; that is to say in box 28. Any ticket may be found very readily by looking over those in the box corresponding in number to the last figures of the car number. When the car has been forwarded the ticket is removed from the case and filed in a box containing six drawers, two compartments in each drawer, to provide a separate compartment for each month. Each compartment is provided with 100 pockets numbered in conformity with the original case to enable the tickets to be found more readily when necessary to refer to them.

For the special purpose of checking car movements in connection with per diem charges, one road uses a case divided into 310 pigeonholes, numbered from left to right, 1 to 31, indicating the days of the month. On the sides of the case are the numerals from 0 to 9 inclusive reading from the top down. A blank ticket, of suitable size, is made for each car giving car number, initial and date of arrival and such other information as may be deemed desirable. Car 27,342 arriving Oct. 10 would be placed in column 10 on line 2. The yardmaster can tell at a glance what cars are being delayed.

A bill rack may be so arranged as to enable a closer check to be kept than the last described plan. To accomplish this a " rack " should be made for each division, connection, branch or other forwarding destination. The case contains ten boxes from left to right (horizontally) with five compartments in

each or five boxes deep. The original or accompanying card tickets for the cars are placed in the boxes according to the last figure; those for cars arriving between midnight and 8 A. M. in the upper; those between 8 A. M. and 4 P. M. in the second tier and those between 4 P. M. and midnight in the third. Cars remaining over a day are then placed in the next tier — "yesterday" — and those two days or more old in the lower tier — "day before yesterday." The bill rack is made on the following plan:

NEW YORK DIVISION										
	0	1	2	3	4	5	6	7	8	9
12 midnight to 8 A. M.										
8 A. M. to 4 P. M.										
4 P. M. to Midnight										
Yesterday										
Day before yesterday										

At midnight the bill clerk moves all bills or cards remaining in tier "yesterday" to the one just below and those from the three tiers above to "yesterday." Additional tiers may be added if deemed desirable. A glance will show any cars remaining in the yards more than eight hours.

In connection with the last described system, or with any system, the use of a dating and timing stamp is valuable. A simple and cheap stamp is used having a time dial, which is set by hand just before the bills for an incoming train are distributed and with which each card ticket or bill is stamped. This records the yard, date and time and answers many questions. The clock time stamp is more expensive and also more liable to get out of order. It does not serve the purpose any better than the hand-set machine.

As the practice of rating locomotives on a tonnage basis is nearly universal, a considerable portion of the time of the yardmaster's force is taken up in computing the weight of

trains, by taking the weight of each car plus contents when loaded, and adding them together. Much of the time of the bill clerks and train crews can be saved if tonnage-computing machines are furnished for this purpose. These machines have been in use at some heavy forwarding points and, while they will get out of order occasionally, are on the whole very satisfactory. In addition to saving time they insure accuracy and eliminate controversies between the train conductor and the yard clerk or yardmaster in which the conductor always thinks he has too much load while the yardmen think another car or two should be added. The yard clerk while adding up the weight of his car tickets is frequently interrupted by questions. The tonnage computing machine holds his place for him; that is to say, he may go to some other work and as soon as he returns continue on the machine just where he left off, provided he keeps the tickets counted separated from those not counted.

With a properly designed and operated terminal, where "hold" cars and "diversions" do not exist, where the conditions are ideal, the records may be dispensed with altogether. This necessitates a yard with double-end tracks, continuous in and out movements and abundance of road power. The conductor of the incoming train hands or telegraphs the list of cars making up his train as they stand from the engine back. The ram or summit engine crews "cut" from this list and the signal man arranges the ladder switches from the same list. Cars for certain destinations are run into certain tracks and the signal man keeps a list of cars in each track by which the outgoing road power is ordered. The cars moved by an outgoing train are checked off; the date and time of that movement being added. Cars would always be moved in rotation, that is to say the oldest cars would go out first.

The author worked up a switch list some years ago, to be used as an advance report of the trains, indicating the position of each car in the train. This was to be copied by the receiving operator on manifold paper and a copy furnished the "cutter" and others on the pole or summit engine. The form as given below was intended for a New Jersey terminal,

and while not as full as others, seems to have some merit in the matter of simplicity and brevity. Columns for initials and numbers of cars could be added if deemed desirable. The following cipher code was printed on the inside front cover of each book of forms, and it will be observed that in "destinations" similar characters were used for connecting roads; others for Brooklyn deliveries; others for New York piers, etc.

A. B. & C. RAILROAD

............................*19*....

Train............ *Eng*........... *Left*...............

at.........*M. has*.....*cars*.............*tons, in following position from head end.*

...................................*Engineman.*

...................................*Conductor.*

	Lading.	Destination.		Lading.	Destination.		Lading.	Destination.
1	....	....	26	....	....	51	....	....
2	....	....	27	....	....	52	....	....
3	....	....	28	....	....	53	....	....
4	....	....	29	....	....	54	....	....
5	....	....	30	....	....	55	....	....
6	....	....	31	....	....	56	....	....
7	....	....	32	....	....	57	....	....
8	....	....	33	....	....	58	....	....
9	....	....	34	....	....	59	....	....
10	....	....	35	....	....	60	....	....
11	....	....	36	....	....	61	....	....
12	....	....	37	....	....	62	....	....
13	....	....	38	....	....	63	....	....
14	....	....	39	....	....	64	....	....
15	....	....	40	....	....	65	....	....
16	....	....	41	....	....	66	....	....
17	....	....	42	....	....	67	....	....
18	....	....	43	....	....	68	....	....
19	....	....	44	....	....	69	....	....
20	....	....	45	....	....	70	....	....
21	....	....	46	....	....	71	....	....
22	....	....	47	....	....	72	....	....
23	....	....	48	....	....	73	....	....
24	....	....	49	....	....	74	....	....
25	....	....	50	....	....	75	....	....

Ciphers Used

For Destination

BA — N. Y., N. H. & H. R. R.
BC — Long Island R. R.
BF — N. Y. C. & H. R. R. R. via 23d St.
BG — Erie R. R.
BH — West Shore R. R.

CA — Palmer's Dock, Brooklyn.
CB — Brooklyn Wharf & Warehouse Co.
FA — 43d St., E. R., New York.
FB — Pier 2, N. R., New York.

For Destination

FC — Pier 44, N. R., New York.
FG — Pier 56, N. R., New York.
FH — 128th St., E. R., New York.
FJ — 31st St., E. R., New York.
FK — 39th St., N. R., New York.

GA — Jersey City Terminal.
GB — Jersey City Transfer Pier C.
GC — Jersey City Pier G.
GD — Jersey City Pier H.
GF — Jersey City Pier I.
GH — Jersey City Grand St. Coal Pockets.
GJ — Jersey City Grand St. Yard.
GM — Jersey City Johnson Ave.
GN — Jersey City Engine House.
GR — Jersey City Bergen Neck Power House.
GS — Jersey City Johnson & Wilson.
GU — Jersey City Union Building Material Co.

HA — Oak Island Yards.
HB — Communipaw Abattoir.
HG — Eagle Oil Works, Communipaw.
HD — Standard Oil Co., Constable Hook.
HF — National Storage Co.

For Lading

A — Live Stock.
B — Live Poultry.
C — Dressed Beef, Meat and Provisions.
D — All other fast time freight.
F — Grain.
G — Flour.
H — Cement.
J — Pig Iron.
M — ....
N — ....
R — ....
S — ....
U — Coal.
W — All other slow freight.
X — Empty Refrigerator.
Y — Empty Produce.
Z — Empty Express.

Every yardmaster should personally keep a log record. In this all incidents out of the ordinary are recorded. Accidents of all kinds, unusual weather, inability to obtain necessary road or yard power, injuries to employees, obstructions on the main line and in fact anything that interferes with the smooth working of his yard should be noted. Questions will come up months afterward which, by reference to his "log" may be readily answered.

CHAPTER XIV

MANAGEMENT AND DISCIPLINE

The men employed by a railroad are usually widely scattered and most of them are not under the direct supervision of an officer. Even the conductor of a train cannot always keep the members of his crew in sight. It is essential, therefore, that every man from the lowest to the highest be impressed with the necessity of doing everything that he should do and nothing that he should not do. Every employee should be made to feel that explicit confidence is reposed in him; that the fact of his retention in the service in itself indicates confidence in his loyalty, honesty, ability and application. The author is convinced after many years of experimenting with different systems of discipline that the so-called "spotting" method does not always produce the best results. Men may be browbeaten into doing their work, possibly, with threats of dismissal or the knowledge that they are being watched and spied upon; but this work will be sluggish. It will lack that snap so noticeable on well-managed roads.

Having and showing confidence does not imply absence of supervision. Of honest, open, intelligent and constant supervision, too much cannot be had; when railroad officers try to carry out false ideas of economy there is usually too little. This supervision carries with it constant and untiring education of employees. The value of this is not generally recognized. It is occasionally underrated because of the incompetency of the officers entrusted with educating the men under them.

The influence on discipline of wages paid was noted in the following incident in the experience of the author: There were two railroads in the same section of the country, operating under quite similar conditions, except that one road was financially and physically stronger than the other. The stronger line had the best track, equipment, signalling, etc., and in addition to its ability, in consequence, to get its trains over

the line with certainty, punctuality, safety and comfort, paid slightly higher wages than its competitor. In its terminals the same relatively superior conditions existed. Better facilities and regular road movements kept its terminals open for free movements and this, in turn, made employment in the yards and in train service more desirable and more sought after. The result in the way of discipline may be readily guessed. The strong road had more applicants for positions than it could accommodate; the other line was, at times, hard pressed for sufficient help. The men who were discharged on the former line because of violations of rules or decreasing traffic were usually employed by the weaker road. On the other hand, when men were needed on the stronger line they were generally recruited from among the most desirable employees of the weaker, the latter being in effect a preparatory training school for the former. This was, in itself a system of discipline which worked to the benefit of the stronger road. On the other line, the effect was, of course, the opposite and constantly tended to harass and embarrass its operating officers.

An instance is recalled where a trainmaster undertook to work a rapid and radical reform on his division by secreting himself at unexpected places about the terminals and along the line to watch the performance of his men. It worked for a few days. The men inaugurated a very complete and successful method of checking the trainmaster. By a system of hand and telegraphic signals they kept themselves thoroughly informed as to his whereabouts. The watcher was watched. The result was the opposite from that desired by the trainmaster and the lack of confidence shown in the men did not increase their respect for their superior officer.

By proper and discreet handling, any division or terminal officer should secure the confidence of his men, at least of the better element among them, so as to enable him to keep reasonably well informed of any general violation of rules or serious defects in judgment. This will enable him to keep the whole machine pretty well keyed up. The men will do this, usually, for their own protection and the general good if it is

carefully explained to them so that they will see it in the right light and understand the advantage to themselves.

The following is from the *Railroad Gazette:*

"A high corps spirit is one of the valuable assets of a railroad company. Perhaps in times of close competition it is one of the most valuable. Money cannot make this; general orders cannot make it; it is a plant of slow growth. A year of arrogance, or stupidity, or coarse sense of justice, may destroy the growth of years. We have all seen, time and again, examples of the truth of this statement; and here we suggest a matter for the serious meditation of the gentlemen who have suddenly taken on such importance in the railroad world. The prosperity of a great undertaking depends ultimately on the skill, zeal, and devotion of its servants. That fact we cannot get away from, although we are sometimes tempted to forget it. No ability in combination of ownerships; no lavish expenditure in physical improvement; no headquarters orders for economy all along the line, can command prosperity without the devoted coöperation of the working staff.

The notions which underlie * * * the modern theory of railroad organization are careful selection with regard to physical, intellectual and moral qualities; steady promotion by merit, with decent regard to seniority, other things being equal; constant watch of the corps and prompt removal of vitiating elements; fixity of tenure."

Hard and fast rules with reference to discipline cannot be made. The question resolves itself into getting as much for your money as you can. The law of supply and demand largely governs the labor situation and operating officers must adapt themselves to the condition. The "labor question" is one of the primary factors in building up discipline. The rate of wages has an important bearing on discipline. A traffic officer has said that freight rates were regulated by "comparison, competition and compromise." This holds true of the adjustment of wages.

With the enormous growth of railroad traffic and the consequent necessity of closer attention to details, with the introduction of intricate machinery, as in automatic and mechanical signaling, the age of the "specialist" in railroad work has been reached. Special training is necessary to care for special branches of railroad work. The specialist in his legitimate field, with correct methods and under a proper system of organization, is of great value to the railroad as a whole and indispensable to the special work in which he is engaged. By placing these expert observers in position to ignore or

harass the local or division officers, however, and having them report direct to general officers, the effect on the organization may in some instances be bad. A feeling may be created among subordinate officers that no matter what they do, whether good railroad practice or not, they are liable to be criticized by one of the specialists. Under certain methods of organization, these men may occupy the position of being able to claim what glory there may be for good results, while not being responsible for any poor showing that is made. As a rule the specialist is a theorist, strong in his convictions. He is invariably closely in touch with the head of the company. It is dangerous to oppose him, except in a diplomatic way, which takes time and taxes the mind and patience of the operating officer. It annoys and worries him and takes his mind from more important work. Nothing is more distasteful to the subordinate official than the demand for letter-writing, to the neglect of his work and, consequently, losing touch of the actual details, personal knowledge of men, etc. It is distasteful, for the subordinate sees nothing gained by it, while the time he is frittering away is largely lost for the work he is anxious to accomplish and which he knows would produce beneficial results. A certain amount of letter-writing is necessary. The remarks made apply only to the instances where the specialist is only partially equipped for his position of authority.

The working officer whose time is largely taken up with office correspondence is in the same difficulty as the engineman who fritters away his air pressure on a long descending grade by making a number of light applications without giving time to recharge his reservoirs. In both cases the operating officer and the engineman are traveling down-hill at an increasing rate of speed and both will soon enough hit the bottom very hard.

A so-called expert was recently appointed on a trunk line. His duty, so far as could be determined, consisted in making recommendations to increase the safety of train movements and following them up to see that they were faithfully carried out. On the face of it, this seemed commendable and

desirable. The expert was an extremist and was in no way responsible for congestion to traffic or increased cost of handling. A rapid-fire gun was directed against the division officers; impracticable propositions were advanced along with a few good ones to prevent accidents. Some of them would have put the road out of business during the months of heavy traffic; most of them involved increased cost; while many of the recommendations could not be entertained. They kept the division officers on the defensive, glued to their desks explaining why they should not be acted upon. It did not have the effect of improving the service, as the officers could not give the work the close personal attention they did before the advent of the specialist. This is merely one illustrative case where the specialist retarded the work of the machine, instead of aiding it.

Men who are trained in special work only, and not on broad lines, can only hope to advance in narrow lines. A road foreman of engines, for example, who only interests himself sufficiently to know that engines are being properly handled and fired, is hardly competent to fill the position he holds. Any engineman could, or should, know and do as much. The road foreman's position is one above and beyond the capabilities of the ordinary engineman. If he does not interest himself in matters outside of the management of an engine, he harasses; he does not help. It is safe to say he will not be considered good timber for advancement to a higher position. The extent to which he interests himself in all operating problems is the measure of his ability to fit himself to assume increased responsibility. It is not to be expected that any employee will be considered in connection with a position carrying with it increased responsibilities and compensation until he has demonstrated that he not only is capable of, but actually is, earning more than he receives in his present position.

Mr. George R. Brown, while General Superintendent of the Fall Brook Railroad nearly 20 years ago, formulated and applied what is now known as the "Brown system" of "discipline without suspension," or punishment without loss of pay. It was new in detail only, for some of its important

features had been tried on the Pennsylvania. The essential features of this system are keeping a record of an employee's irregularities in the performance of his service as well as of acts of special merit and posting bulletins containing brief accounts of the incidents, causes and lessons connected with each record entry.

Many roads use the Brown system in a modified form. Some use the "record suspension" for every offense, except for cases meriting dismissal; others use record or actual suspension according to the merits of the case or the general character of the offending employee; while others again, use only the bulletin feature. There are varying opinions as to the real benefits to be derived from the record suspension feature and the effect depends largely on the class of men employed. There is, however, a general belief in the beneficial effects of bulletining a history of each offense.

Take the case of a flagman who is disciplined for not going back a sufficient distance to protect the rear end of his train. Under the old system, his disposition would be to misrepresent, to his fellow-workers, the actual cause of his suspension, and, he would make the case look as favorable to himself as possible while, correspondingly, reflecting on the judgment or ability of the officer directly responsible for inflicting the discipline, if the facts in the case are not officially promulgated. The impression is naturally created that the officer is despotic, or unfair and that the employee has been imposed upon. Such impressions have the effect of creating bad feeling, particularly among the lower classes of employees. The bulletining with the Brown system changes this and is the strongest point in favor of that plan.

One modification of the Brown system embraces a record book in which two pages are devoted to each employee; one for the debit and the other for the credit side. The usual entries, covering the employee's age, height, color of hair, eyes, weight, date of service and of various changes or promotions, are made at the top of the page in blank spaces provided for that purpose. For each offense requiring disciplinary action the employee is charged with a certain number of demerit

marks, or nominal days of suspension, and for acts of special merit he is credited with merit marks, or days, which, in some cases are allowed to cancel a like number of demerits or days of suspension on the opposite page. A bad record is followed by dismissal, while a clean record for a given length of time, say, three months, six months or a year, usually entitles the employee to a certain number of merit marks, or cancels a certain number of demerit marks. All roads continue to apply the penalty of dismissal to cover cases of intoxication, insubordination and other extreme offenses.

When a record is entered, on either the debit or credit side of the book, a bulletin is issued containing a brief history of the case and is posted on the bulletin boards at designated points. Locations, names of men, dates, and train numbers, are omitted for the purpose of avoiding attack by agitators and to prevent undue embarrassment to sensitive employees. For similar reasons and to avoid controversy or comparisons the extent of discipline is sometimes omitted. It is customary, too, on some lines to give the actual or estimated amount of damage done where damage results.

The following is an example of a bulletin:

"A freight conductor and flagman have been disciplined for failure to properly protect their train while it was stopped at a point on the main track. The explanation made by these men was that it being daylight, with a good view to the rear and automatic signal protection, it was deemed unnecessary for the flagman to go back farther than he did. While it is true that the signals may usually be relied upon to do their part, a flagman employed for the purpose and out the required distance will doubtless succeed in attracting the attention of an engineman who passes a signal while working on his injectors, water gages, etc., and may also arouse an engineman who has for the moment dropped off to sleep. Leaving out the question of the engineman's neglect of duty in the case, the flagman's attention to duty may prevent a serious accident and possible loss of life."

Another example from a bulletin is the following:

"By throwing the wrong switch in a divisional yard, a switchtender caused cars to 'corner' on a frog resulting in damage to the extent of $1,690 and for his negligence has been disciplined. The investigation developed that he was engaged in conversation with a car rider, and as a result started for the switch too late and became confused because of the short time he had to clear the car. Yard employees, and particularly switch tenders, need to have their wits about them and their minds on their work while on duty. They cannot properly perform their work when engaged in outside occupation, or

dangerous. Shall we bulletin or reward every meritorious act, or where shall we draw the line? The author recalls an instance where a passenger-train flagman went back and remained out several hours in a rain storm, damaging his new uniform. The trainmaster secured the approval of his superintendent for the purchase of a new uniform. A generous act, certainly, but with disturbing results. Why should an employee be specially rewarded for doing his duty? Why should not the passenger-train or freight-train flagman provide himself with a rain coat and rubber shoes, and have them at hand during rainy weather? For a time other passenger flagmen, who had to go back, during a drizzling rain, or while the dew fell heavily, asked for new uniforms. They were highly indignant, too, when their requests were not granted. It is difficult to draw the line accurately between special merit and duty. The damage does not exist in rewarding one employee, but in the fact that always there are a number who are not rewarded though equally entitled to special recognition.

A flagman hanging out of a caboose cupola, saw a broken rail on the opposite track and signalled a fast passenger train preventing it, by quick work, from running over the broken rail and possibly from being derailed. He received a number of credit marks. It was his duty after he discovered the break to notify the passenger train; he had done just what any employee should have done. It was not his duty to look at the rails on the opposite track; he was evidently doing it in a dreamy indifferent way. While looking at the rails of the other track he was not watching his own train, to detect heating journals, break-in-twos, loose car doors, etc., and it was his duty to do this. Incidentally it may be added that this flagman was dismissed some six months later for being intoxicated while on duty.

An engine ran away from a hostler, and got out on the main track, running the wrong track, *i. e.,* against the current of traffic. A switch-tender promptly notified a yard engineman, who got his engine out and overtook the runaway. He climbed over the pilot of his engine, reached the cab of the runaway, shut off the steam and stopped it. This engineman took

some risk, but he received no credit marks. The speed was low, the actual risk taken was probably no greater there than he incurred every night in his regular yard work and his action was considered as being in line with duty.

One of the common, if not the commonest, errors made in disciplining employees is that of considering the results, or effects of a violation of rules or instructions instead of the actual offense. Trainmasters often inflict comparatively light discipline on a flagman who does not go back a sufficient distance to protect his train, provided no damage has resulted. But few trainmasters would let a flagman off, short of dismissal, if his failure to go back the prescribed distance resulted in several thousand dollars' damage, loss of life and a badly blocked railroad. Is this not because the reports in the case with disastrous results will be carefully read and considered by those high in authority? But is the effect on the service desirable?

Of the large number of men in positions of authority over others, who fully understand what is to be done and how it should be done, but a small proportion are successful in their dealings with subordinates. This requires a special tact which is seldom acquired. Men cannot be regarded as so many machines. The human and the humane side of the question must be considered. An interest taken in the general welfare of employees; consideration for their families and an occasional "heart-to-heart" talk with one or more of them will go a long way towards securing their earnest and hearty co-operation.

Nevertheless, a distinguished railroad president of wider and more varied practical experience in subordinate service than most others, comments as follows:

"The arguments for Brown's system are very attractive, but I do not believe the method is adaptable to this wicked world. You may catch flies with molasses, but our lives, our fortunes, our civilization we owe to our jails, penitentiaries and gallows. Next to the influence of the labor unions, I think the greatest element in the general deterioration of discipline, so manifest in late years, is the general use of Brown's method. The records should of course be kept. They were kept by the Pennsylvania lines before Brown's system was heard of. My experience leads me to believe that the bulletins soon fail to be read by the men. If the investigations are properly conducted, with all the men of the crews present when the finding is announced, and pains

then taken to draw and enforce the lesson, I believe in the long run much better results are obtained. As to punishment, I do not see how we can safely eliminate it, and in any event the gap is wide between chiding and dismissal."

The yardmaster in charge of a terminal should have the authority to make minor changes and not be compelled to go to some one higher in authority for approval of them. If he is not competent to exercise this authority he is not the man for the position. But if he is capable he may be so handicapped by instructions regarding details, as to render his administration a failure. The nature of the work often requires quick, intelligent and positive action. If more engines are needed, or additional men with certain engines, he should put them on and not be required to waste emergency time in explaining and asking authority to do so. Conditions frequently arise where a delay of a few hours or even minutes may cost much more than the expense of preventing it. A sluggish road movement may be followed suddenly by a heavy run into the terminal. A derailment in the terminal may create a condition necessitating help in a certain district to enable other parts of the machinery of the terminal to keep up speed. Failure to supply the necessary help with men or engines may cause a complete cessation of work through the clogging of one part. Allow the yardmaster to act in emergencies, and explain later. If he has not the capacity, get rid of him. Much of the loss through inefficiency is in the general hunt for lost cars which have strayed into various single-end tracks, and in tracks where they did not belong, in the anxiety to keep things going. This is invariably followed by lists of cars furnished by the traffic department which are wanted in preference to others. Efforts are then made to switch these particular cars out from a number of others; an operation of questionable wisdom.

A certain terminal was badly congested in the early winter, through a penny-wise, pound-foolish policy. On account of the constant heavy run of freight this terminal was not cleared until there was a considerable decrease in the freight movement in the following spring. In this case the yardmaster and the trainmaster were wide-awake and fully appreciated the

situation and anticipated the condition approaching them, but were not empowered to act. For every dollar they wanted to spend to keep things moving, the company afterwards spent five hundred. In this were included heavy claims paid for freight damage by detention.

The reader knows doubtless of similar instances; in any event, he has read of many cases in the newspapers during the last few years, of "congestions" in big terminals, that seem to indicate incompetent terminal managers. It is convenient to charge it up, in the newspapers, to "abnormally heavy traffic." Somebody should have seen it coming and received it with guns loaded.

The manager of the terminal, the yardmaster, must have his organization in such shape as to require but a small proportion of his time to be spent indoors. He should have a free hand to come and go at will, and occupy his mind with the larger and broader proposition while not overlooking the smaller. It is his duty, and during the season when his yard is heavily taxed, his salvation to know all he can possibly learn in advance of heavy and unusual train movements, to prevent his being caught in a state of "unpreparedness." As to how far ahead he should look for heavy traffic movements, he should look as far as he can see and farther. This Hibernicism means that he should get information from those who have the means of knowing more than he does of the probable amount of freight traffic to be handled. The men at the head of the traffic department are always well informed on these matters; for, their representatives are scattered over all parts of the country and are required to make reports to the general officers. This information is then conveniently tabulated. Conferences with the traffic officers, as frequently as practicable or necessary, should secure much information as to amount, kind and direction of anticipated traffic. While something of this kind is usually done, the author knows of no road where it is as thoroughly gone into as it should be.

The yardmaster should know when his organization is perfectly balanced and keep it so by making the necessary adjustments as needed. The terminal system or "cluster" is

usually divided into sub-yards or districts. It is the practice to put one or more engines into each district. Satisfactory service follows when an engine, with its crew, is kept in the same work. Because of the comfortable, easy working of this method, an engine is often continued in its district, although the business may have decreased one half, or the engine in the classification yard may be unable to keep up with its work, while the engine in the shop-yard, or at the transfer platform may have enough spare time to assist the former. Sometimes the work may be facilitated and the necessity for additional engines obviated by adding one or more car-checkers, brakemen, switch-tenders or car-riders. It can be readily figured out how many men may be added before reaching the cost of an engine and its crew.

Through the follies of "red-tape" or the employment of men in whom no confidence is felt, it is occasionally left to the yardmaster to add engines and crews, as he deems necessary, while to get an additional car-checker he is compelled to go to Rome and back again. He has to make out an application which passes through the hands and requires the approval in turn of the trainmaster, the superintendent, the superintendent of transportation, the general superintendent, the general manager and finally — after passing one or more vice-presidents or assistants or assistants *to* — reaches the president. After all approvals have been regularly affixed, the return trip is made through the same channels. This because the car-checker comes under the head of "fixed force." By the time the yardmaster gets his authority for the employment of the car-checker the necessity for the additional help may have passed. It is therefore not to be wondered at that instead of asking for the assistance of the man to tide him over the impending crisis of a heavy run of freight, or of bad weather to-morrow or possibly to-night, or even to-day, he calls for the engine with its five or six men. He adds an expense of something like $25 instead of $2 or $2.50.

This preponderence of machinery works loss in another direction: A yardmaster knows he can dispense with the services of one or more clerks, checkers, switchtenders or others of

the " fixed force " as the business eases off, in the Spring presumably, but that he will again require this help in the Autumn, and probably on short notice. He has also learned, from experience, that it will take a long time to get his applications through. It is not surprising then that he makes up his mind that " a bird in the hand is worth two in the bush," so he keeps the useless men on the payroll all summer.

In the author's experience, a yard engine was required to take care of one of the freight houses and certain yard work in a large city, along with the near-by coal pockets. During the fall and winter months when general freight required much attention the coal would run heavier and it required several hours' work of the engine each morning to push the loaded coal cars to the foot of the approach to the coal trestle. They were then hauled to the top by a cable attached to a drum. From the top of the incline the loaded cars were dropped by gravity over the various pockets and then by gravity over a switch-back arrangement to the empty-car track, on which they were returned to a track alongside the starting track. This method had been followed for years; in fact since the coal pier was built. It had never occurred to any one that an improvement could be made. The yard engine's inability to do all its work and the fact that the freight platform was being neglected, notwithstanding the men worked overtime, did not start a train of thought anywhere. But with an old hoisting engine, found in one of the scrap piles, when connected up to the stationary engine boiler at the foot of the incline, at a total expense of not exceeding $100, 30 or more loaded coal cars, or enough for the heaviest day's work, were placed on the approach tracks at one operation, and from thence were reached by a cable and drawn, by the stationary engine, to the foot of the incline. No additional men were needed at the coal pier and several hours' time was saved each day for the busy yard engine, a saving amounting to upwards of $200 a month.

Close scrutiny of the work at a transfer station, a manufacturing plant, a shop yard or other " side issue " may develop a feasible and advantageous change in the manner of doing it. A consolidation with other work will sometimes

make possible a saving of half a day's work for an engine. A slight change in the track lay-out or the addition of a switch or two in the yard of some private industry may make possible a reduction in engine service. Because a reliable conductor has been following up the work in a district for years it must not be assumed that he would see all the possibilities for improvement. He may be conscientious enough to tell about it if he saw it; he is nevertheless liable to fall into a rut. Men are creatures of habit. A condition may to-day be noted in yard operation that seems, and is, entirely irregular or improper. For some reason it cannot be got at immediately and is permitted to exist for a time. After seeing it day by day for some weeks it begins to grate less harshly on the nerves and after a while does not attract one's attention. This is a condition to be avoided. It becomes a habit or custom to do yard-switching at outlying points at a certain time of day. It may be done more advantageously at some other time. A different hour may benefit the work at another point.

Frequent interviews with the managers of manufacturing plants and other industries requiring special switching service will often suggest a plan whereby work may be cut out to the mutual benefit of both corporations. Aside from this, however, such interviews usually do good by enabling the yardmaster to keep in close touch with the road's patrons and learn of objections to, or irregularities in, the method of doing switching before they assume the proportions of a formal complaint. The manager of an industry is encouraged to advise the yardmaster direct of his wants, thereby securing the most direct and satisfactory results, and he may give the yardmaster valuable suggestions.

It is customary to use worn-out or light engines for yard work. Light engines are suitable for certain kinds of yard work, and in such cases there can be no possible objection to them, but in many instances their use in yard service is extravagant. An engine in a classification yard should be sufficiently powerful to handle as many cars as a road engine brings in, and to start them quickly. It requires just as many men to man and follow a small worn-out engine as a larger en-

gine designed for this class of service, and it usually burns as much coal, while the larger engine will perform much more work. Two engines in a yard will usually interfere with each other and, of course, will interfere more with road engines and other yard engines than will one. It is questionable economy to use in yard service road engines not adapted for quick starting and stopping and from which signals cannot readily be seen, fore and aft, and from either side.

One of the first desiderata in a yard is the delivery of incoming trains with regularity, and another of nearly equal importance is to have outgoing trains start as soon as they are ready. This is almost wholly within the province of the chief train dispatcher and, barring shortage or bad condition of locomotives, he may substantially carry out the yardmaster's wishes; or, in edging over, one way or the other, he may materially embarrass him. Thorough harmony and frequent conferences are necessary. A yardmaster dreads having a number of ordinary freight trains coming in close ahead of a stock or other fast freight train demanding preferred attention. In this the chief train dispatcher can be of great assistance by keeping informed as to the yard conditions, and in turn, informing the yardmaster as to road conditions. The holding back of freight trains may on the other hand be carried to excess and result in greater embarrassment when they finally come in "bunched" faster than they can be comfortably handled. There is a line to hew to in this as in many other things, and it is the intelligent chief train dispatcher with a good supply of common sense and discretion who finds it. When freight is heavy, and in bad weather, the chief dispatcher may, by figuring far ahead, keep the terminal well supplied with power for outward movements by adjusting the tonnage rating of locomotives to weather changes and by insisting on good dispatching. In this manner he will do much towards getting trains over the road promptly. If the locomotives are overloaded or if the trains are neglected on the road, remaining too long on sidings, neither the locomotives nor the men will be available for early use when they get into the terminal. Unless there is an abundance of motive power

and men, a congestion is liable to result because of inability to start trains out when they are ready. The situation becomes aggravated by the necessary holding out of approaching trains because of such congestion. This in turn renders more locomotives and men unfit for service.

The chief dispatcher should watch the tonnage rating and make readjustments as frequently as conditions make them necessary. The government weather report should be got from the nearest signal station, both the full detailed daily mail reports and the more frequent brief telegraphic advices. Weather reports by wire must also be got from designated railroad telegraph stations along the line at stated times, and during threatened or existing storms at additional times. Close watching of these reports and other data will often keep a road open and going where a little neglect would cause a blockade. A train must never be permitted to become stalled in a snow storm if there is any possible way to prevent it. The temperature reports from the different stations are of great value.

Much interest was manifested in a recent discussion on "team work in railroading." An inefficient officer cannot succeed; one who is capable cannot succeed without the co-operation of his fellow workers, but may succeed with that co-operation. The spirit of "the company for all; all for the company" is as essential to success as are the two rails upon which the wheels roll. Organization, method and system are absolutely essential to success in such an intricate undertaking as the working of a large yard.

Abraham Lincoln said:

> "When people saw Stephen and Franklin and Roger and James, each working independently, as they proclaimed, turning out mortised timbers which fitted perfectly together to complete the framework of a house, with not a stick wanting and not a stick superfluous, it was natural to conclude that Stephen and Franklin and Roger and James were operating according to a common plan."

CHAPTER XV

The Yardmaster

The yardmaster leads an eventful life. Receiving, sorting and dispatching large numbers of small parcels without error requires alertness, precision and accuracy. The yardmaster must have these qualities, but when, for parcels, we substitute huge complicated vehicles, occasionally broken and always breakable, coming in irregular flow and numbered by thousands, the yardmaster needs to be something more than a parcel-handler. Every unusual incident hinders him, nothing helps him, for his work is movement, his danger is blockade. It is quite unlike the work of the engineman, because he cannot make the movement approximate uniformity. Cars come to him in bunches, to be unloaded, or sorted into new trains, or repaired and sent forward — always sent forward, for his bailiwick is simply a part of the main line of movement, slightly expanded for his purposes of breaking up and marshalling trains. A blockaded yard means a blocked road, an absolutely useless, expensive tool, and this the yardmaster can make in a day, not necessarily by doing the wrong thing, but by not doing enough. In times of emergency, to err on the side of safety is not, as in many other kinds of work, to watch and wait. This is fatal. The yardmaster must do something vigorously, even if it be far from the best thing, and keep on going without for a moment admitting an impossibility. The ideal man for this work should have an aptitude and ingenuity for meeting small and great emergencies quite beyond the ability to follow rules. In a big terminal, the difference in value between a good yardmaster and a poor one may amount to a president's salary.

There are many yardmasters who are retained because they are not well watched. Their highly expensive operations may be lower than those of other yards — although such other yards are handled more successfully. Then apparent comparative success may be due to the congestion existing in other

more difficult or crowded yards diverting attention, or to the erroneous assumption that yards not complained of are well handled.

The yardmaster who is competent to handle a difficult situation is not always estimated at his full value. This may be due to superficial criticism by chief clerks, and others without practical experience in the offices of the superintendent or general superintendent. Their superiors are busy and the yardmaster may lack the time or educational training necessary to convince. An awkward location, want of facilities, unadaptable motive power, insufficient wages paid to secure competent or reliable help, bad make-up of trains approaching the yard, and requirements as to make-up of outgoing trains — these are among the conditions that occasionally give the good yardmaster a bad name.

The question was asked a well-known transportation officer: "What kind of a man does it require to satisfactorily run a big yard?" The reply was "The kind of a man who can run this United States Government." The ability to do things cannot be overestimated. It is better to risk censure for doing something than for doing nothing. When a washout, snow-blockade or other obstruction closes the line and cuts off communication, it is gratifying to discover afterwards that somebody took the responsibility to start relief trains and get things moving — that somebody did something. There are men of the other stamp who do nothing unless told and who have to be told everything and then do but a part of what they are told. They are comparable with the engineman who wires the dispatcher that his engine is disabled and asks what he shall do.

The greatest difficulty in securing competent help and in honest, capable workers securing positions of trust, exists in the very limited number of persons who may be known intimately by any one employing others in positions of responsibility. Many are in need of faithful and efficient help; many deserving workers need employment. While awaiting a train at a point where it stopped to take on a dining-car, at the foot of an Allegheny Mountain grade, one cold winter's morning, the author was impressed with this fact in observing the actions

of a man whom his fellow-workers called "Jim." "Jim" was the pumper at a salary of $45 a month. His regular duty was to run the pump and look after the unloading of coal for use on the helping engines. One of the helping engines got the dining-car off a siding and brought it across the two main tracks to attach it to the rear of the eastbound passenger train. "Jim" left his pump, made the couplings between the engine and dining-car, gave signals and went up into the interlocking tower several times to coach the relief signalman who had not been there very long and did not understand the levers. The engineman and fireman made no move to do anything outside of their regular work; the signalman was incompetent to do his own work and made no move outside of that. "Jim" alone did things and kept everything going. He was a young man who had worked at that place and in that same position for years and was never heard from because he did things right and corrected mistakes of others. The engineman, the fireman, and the signalman, doubtless, called on the division officers frequently to explain delays, failures or to present "grievances." "Jim" was worth more than all of the others, but he was kept out of the more responsible and remunerative position he deserved because the officers did not know him intimately or lacked the moral courage to change anything at the little mountain station that might cause them some slight, temporary inconvenience.

To gain and hold the support of his men, the yardmaster must have their confidence and respect. This will be given him if he is a man of good character and knows his business. Respect is not accorded a man who is incompetent. In manner he should be quiet and unassuming, but in conduct just and firm. He is assumed to have been one of the men with whom he works. He should continue to associate with them sufficiently to know them thoroughly while preserving the necessary amount of dignity to prevent even an intimation of favoritism.

A successful yardmaster, in a difficult yard, had been advanced from the position of freight conductor. While in charge of a train he had the draft timbers pulled out of the

front end of a refrigerator car loaded with fresh meat. It was impossible to chain up or replace the drawhead. Trains were not frequent, it was a long distance to the terminal and shops, and the business was highly competitive. The conductor made his plans and immediate action followed. He pushed the car and part of his train back to the next sidetrack in the rear. The brake rigging was disconnected, one truck of the car was run down the main track and the other truck on the siding. The trucks were worked back in this way until the car body stood at right angles to the main track. The truck on the main track was then worked forward. This turned the car, end for end, after which it was coupled to the rear of the train and moved to its destination. That this man was selected from a large number of employees to fill the responsible position of yardmaster in a heavy terminal does not seem surprising. The way in which the trouble was met and overcome is characteristic of the man who is full of resource — who is prepared to meet any emergency and who is a man of action.

Ralph Waldo Emerson gives his impression of the successful worker:

"I look on that man as happy, who, when there is question of success, looks into his works for a reply — not into the market, not into opinion, not into patronage. In every variety of human employment, in the mechanical and in the fine arts, in navigation, in farming, in legislating, there are among the numbers those who do their work perfunctorily, as we say, or just to pass, and as badly as they dare — there are the workingmen, on whom the burden of the business falls — those who love work and love to see it rightly done, who finish their task for its own sake, and the state and the world is happy that has the most of such finishers. The world will always do justice at last to such finishers; it cannot do otherwise. He who has acquired the ability may wait securely the occasion of making it felt and appreciated and know that it will not loiter. Men talk as if victory were something fortunate. Work is victory. Wherever work is done, victory is obtained. There is no chance and no blanks. You want but one verdict; if you have your own, you are secure of the rest. And yet, if witnesses are wanted, witnesses are near. There was never a man born so wise or good but one or more companions came into the world with him, who delight in his faculty and report it. I cannot see without awe, that no man thinks alone, and no man acts alone; but the divine assessors who come up with him into life, now under one disguise, now under another, like a police in citizen's clothes, will walk with him, step for step, through the kingdom of time.

"What is vulgar, and the essence of all vulgarity, but the avarice of reward? 'Tis the difference of artisan and artist, of talent and

genius, of sinner and saint. The man whose eyes are nailed, not on the nature of his act, but on the wages — whether it be money or office, or fame — is almost equally low."

When the position of yardmaster has been satisfactorily filled things move smoothly. When or how this is done is not apparent to the casual observer. Good yardmasters do things. They do not usually tell much about what was done or the manner in which it was done. This is unfortunate because many of their "shop kinks" are valuable and they would make interesting and instructive reading. In numerous details they make themselves felt and only their close associates know how it was done. There was a case not long ago where a yardmaster who knew his business supplanted another who was supposed to be a first-class yardmaster and whose yard was being handled without criticism. It was not so badly congested or expensively handled as some others. The new yardmaster decided there were more men accompanying the engines than seemed necessary. It was explained to him that curves and certain obstructions made it necessary to have one man to pass or repeat signals. He had several of the engines turned around enabling the engineman to take signals direct. In this manner without detriment to service, he was able to take one brakeman off of each of five engines. As these men were paid $2.40 a day this resulted in a saving of $12 a day or $4,380 a year. The reader will probably ask why it did not occur to some one to make this slight and insignificant change by which the new yardmaster saved double his salary. These little things which should be apparent to every one are the ones to pass unnoticed.

The author recalls a case where an engine was compelled to work headed towards a coal storage plant on the approach grade, placing the engineman on the outside of a curve and on the side opposite that from which the switching was done. It was necessary to repeat signals through the fireman, and, as a result, detentions and accidents occurred. At an expense of a few dollars the engine was made left-handed, that is to say, the throttle, reverse lever, air-brake valve, etc., were placed on the left or the fireman's side. The engineman, thereafter, rode on the left side and took the signals direct. The saving of one brakeman's wages was effected and the amount lost in acci-

dents materially reduced. A simple move and one anybody could have made, yet nobody thought of it.

In many instances money may be saved by connecting up near-by switches to distant levers through the use of pipe lines, enabling one switch tender to cover the work of two or more. The use of spring switches on inside tracks where movements are normally in one direction, has already been referred to.

A superintendent whose engines ran into and turned in the terminal at one end of the adjoining superintendent's division, complained bitterly of the detention to his engines in the terminal. The yardmaster spent much time in explaining why the engines could not be got around more promptly and in this way the stereotyped complaints and explanations mechanically followed each other. The superintendent in charge of the terminal, tired of this unproductive work, and made an investigation in person. After a careful analysis he found that the trains coming in with engines to be turned were made up of about one-half their cars to the next division terminal beyond, while about the same number of engines that were not to be turned had about half their cars for the first terminal. In other words the through and "turn-back" trains and their engines were being badly delayed because of the switching, which work was made necessary by the neglect of the yardmaster at the last division terminal back, and for which the superintendent making the complaints was responsible. There is nothing to be said in defense of the yardmaster who had not the intelligence or interest in his work to inform himself as to the conditions existing instead of contenting himself with writing letters explaining his own shortcomings. This may serve to illustrate the difference between two types of yardmasters — the broad and the narrow gage. This man worked in a rut.

While in charge of a busy terminal yard where 12 or 14 switching engines were working at one time the author devised a plan to make up for the time lost by each engine and crew of from five to seven men while the engine was run to and from the engine-house to have fires cleaned, coal, water

and sand supplied and minor repairs made. This usually occurs when the engine is most needed and is a source of annoyance to the yardmaster and expense to the company. A "relief" engine was put in service manned by a hostler and a helper. It started out in the morning following a regular schedule in going to one engine, taking it back to the ashpit while leaving the "relief" engine for the regular crew to work with, returning the yard engine to its crew and then moving on to relieve the next engine. One engine and crew were dispensed with in this way and the remaining engines and crews were kept moving continuously at the cost of one hostler and helper. This plan is still carried out in the yard referred to.

The author was once told by a yardmaster in a busy switching yard where much placing of cars had to be done for local industries on crooked and steep-grade tracks, that in the face of enormous opposition he reduced the number of men in each switching crew by one man. It was claimed that the work could not possibly be done and that accidents would increase in number and extent. After a test of one year his accident account was found to have been reduced 30 per cent., while an increased amount of business was handled without additional engines. The author does not vouch for the correctness of these figures, although he has no reason to question them, and can readily see how the result might be attained. In a measure it reflects on the discipline of the yard under the previous management. This is in line with the reasons given by the roads operating wide fire-box engines as to why an additional man should not be placed on engines to take the engineman's place in case he dies of heart disease. These roads argued that instead of securing additional safety the opposite would probably result, as the two men would spend much of the time "visiting" and nobody would be on the look-out.,

The congested or blocked yard will happen occasionally. No general plan of action can be formulated to successfully cope with this trouble. The first attention should be directed to the inward movement with a view to stopping or reducing it. The demands and threats of shippers and the traffic of-

ficers should not be permitted to influence other action; they themselves will be the greatest sufferers if heroic measures are not adopted and faithfully executed. Switching room is as essential in a yard as is an open main track for train movements. The incoming freight may be stopped by placing a general embargo, by sidetracking on the home road or in such other manner as may be determined under the conditions existing. After the disease has been diagnosed its cause should be removed. If this is lack of power or improper handling of power on a connecting division, that difficulty needs attention. A foreign connecting road may not be moving its cars because of indifference or inability; a large industry may not be unloading promptly or may be receiving more material than it can handle. Be that as it may, the cause of the blockade should be quickly eliminated. Sufficient forces may not be provided to take out as many cars as are brought in. This can result in but one thing, a blockade, and it is only a question of time when that end is attained.

The blockade troubles may be aggravated by the action of a weak yardmaster who is overawed by a chief train dispatcher and permits one of his main tracks to be blocked. After this track is filled — whether a single track or one of two double tracks — the yard is in worse condition than it was before. It has the additional handicap of reduced switching-room and increased attention necessary on the part of the organization to care for main line trains, while it is in no better shape in the matter of moving cars. When confronted with a blocked yard, no attempt should be made to single out preferred or special delivery cars on urgent requests from anybody. As this stand is taken solely in the company's interest and for the benefit of the patrons, it should be indorsed by everybody from the trainmaster to the president. If the congestion is serious, the efforts of the yardmaster to single out a few cars scattered here and there, instead of taking all in their turn, may cause the condition to continue for months, or until relieved by a gradual reduction in business handled. If, on the other hand, he ignores the special or preferred car orders he may succeed in relieving the blockade in a comparatively short time. It re-

quires some nerve on the part of a freight agent to decline to order a car placed immediately for a consignee who presents a bill-of-lading showing that it is already some two weeks overdue, who can point to his car standing on a certain track in the yard, and accompanies his request with harrowing tales of suffering, loss of business, prospective damage claims, etc. It requires even more nerve for the higher traffic or operating officers to maintain the same stand. The point that is not explained and which cannot be accurately demonstrated is that in all probability 99 cars are delayed as a result of giving, or attempting to give preferred attention to one car.

Mr. Tyter of the Boston & Maine, gave an illustration of the results of such an order in a paper read before the New England Railroad Club, October 10, 1905.

"Many a large yard has been tied up and traffic brought to a standstill in attempting to carry out such orders. I recall to mind a case where ten crews were ordered out on fifteen-minute intervals to clear a yard — the first to leave at eight o'clock in the morning. The trains were marshaled in their respective order; the first, second and third, consisting wholly of perishable freight; the fourth and fifth, merchandise; the sixth and seventh, grain; the eighth, ninth and tenth, coal and other dead freight. The conductor of the first crew had his train recorded, his bills checked up, and his running orders when a message was received from hearquarters to forward on the first train certain cars which had been made up in the eighth train. The yardmaster endeavored to explain the situation, but he was silenced by being told to obey orders, which he did, but the first train did not get out until 11 o'clock, three hours later than it could have left, and from the fact that the yard was filled to the limit, all trains upon the road had to be held back, the whole resulting in a demoralization and a crippling of the service from which it did not recover for several weeks."

The evil of the "hold car" is another obstacle in the way of opening a blocked yard. Where few hold cars are handled or where ample facilities are provided to care for them, the evil may not be a serious one; other things being equal, the annoyance becomes more far-reaching as the number of hold cars increases and the average time of enforced detention lengthens. While it is generally assumed that the term "hold cars" embraces only such as are detained for traffic reasons, any cars held for any purpose, as awaiting entrance to shops, empties held for loads or orders for distribution, embargoed cars, etc., will produce the same effect.

The usual move made, when a blockade threatens, is to put away trains or cars in any tracks that may be convenient in order to temporarily tide over the difficulty without regard to the hereafter. These tracks may be convenient to get into and are usually difficult to get out of. The cars are then overlooked and lost; in any event they cause more trouble afterwards by reason of their getting into the wrong place. These and other temporary makeshifts should be avoided. A well-regulated yard, like a well-ordered house, has a place for everything and everything should be kept in its place. To vary from this practice is sure to cause trouble. The car that finds its way into the wrong and unusual track is a trouble-breeder, and will probably cause enough loss of the time of engines and men to locate and handle several hundred cars that were run into the right tracks.

The yardmaster, like the general in command of an army, must, above all things, retain his composure and control his temper. The worst effect of his failure to do this is in its result in the work of his subordinates. "Like master like man." Little can be expected of men during disturbing times when they see their leader become "rattled" and going about in an excited manner talking and gesticulating wildly. The habit of suppressing any visible signs of emotion or chagrin may be difficult to acquire but it is one that should be cultivated.

CHAPTER XVI

Loading Cars

Automatic couplers accompanied by increasing size and weight of locomotives and cars increase the liability of damage to freight and make necessary greater care in loading and in switching. Freight-house men must be taught to load large cars with package freight so as to prevent shifting. After part of such a car is unloaded, the remainder must be arranged to avoid shifting. When the old link-and-pin couplings were in use, the brakemen had to go between the cars as they were approaching each other to couple and they had to guide the links with their hands. Sticks were used only in the rule books and while within the range of the superintendent's or train-master's vision. The brakemen in those days were, in a sense, law-makers. Their rules, had more weight and were more respected by the enginemen than any issued by the company. This was natural; the brakemen knew the safe speed for hand coupling and they did not hesitate, at times, when narrowly missing the loss of fingers or a hand, to bring powerful arguments to bear on the engineman, backed by a coupling pin or link. These weapons have since disappeared. Urging the yard men to get out trains faster, to do more work in a given length of time, usually results in more damage to the contents of cars. Many serious break-in-twos on the road are caused by damage done to couplers or draw gear while the train was making up in the yard. Most yardmasters and their assistants dislike to reprimand or discipline their employees for doing rough work, so long as no visible damage is done, because they fear a slowing down in the movements of the men. Possibly too, the nightmare of a congested terminal may have something to do with it.

In attempting to reduce the damage to freight in transit — and it is a big field — the panacea is undoubtedly more inspection and supervision of a more intelligent character. British railroads employ many inspectors and their system is

well worth imitating. The General Claim Agent of a large railroad, in a talk with his agents, gave them the benefit of his experience, including much good, solid advice in everyday English, some of which is quoted:

"We always work better when watched occasionally, when somebody comes around to see whether we are doing our work right. Now if you will go into the cars in the morning and see that they are clean and go into them after they are loaded and see if they are properly loaded — you don't have to do it all the time, but just often enough to catch some one — you will catch them every time they do something wrong, then we will have this thing going right. Just give it the supervision that you would give your own business, just give it the supervision that you are paid for giving it. That is one of the things lacking on a railroad to-day. There isn't enough supervision. We don't have enough superintendents and a great many times when we have them they are not the right kind. What we need is more inspectors, more superintendents. The pay roll would be a little higher, but the loss and damage account would be a great deal less — if the supervision was of the right kind.

"You have some places on your line where the cows have calves three or four times a year, and, I think, often they must be twins. Now, don't load those calves (veals) on top of butter. That is not the place for them. The butter tubs are all covered with blood, and the agent at destination has got to scrape those tubs and wash them off with water to clean them. Don't put the heavy boxes and packages on top all the time. Don't make a special effort to put machinery on flour or sacks of sugar and don't put it on automobiles.

"We had a shipment of an automobile the other day where a lot of agricultural implements had been loaded on top of it. The fellow that did it was sure the car would be sealed up and pulled out and put into some train. If he thought somebody was going to look into the car before it was pulled out and find that the freight had been improperly loaded, he would not have done that, and that was a $2,500 automobile — about as delicate a piece of property as we have to handle. See that they are properly braced in the car so they won't run from one end to the other and up the sides and knock the end out.

"Perishable freight we want to load in a refrigerator; if you don't have any ice at your station and the stuff will spoil before it reaches the next icing station or destination, go and get some ice. Don't let the property spoil because you don't want to spend $2 or $3, and in loading a refrigerator see that the waste pipes are open so that the water will run out of the car instead of into it. Refrigerators in the winter time have vents; they have covers on the top where the ice is put in the bunkers. If you leave the pipes open the cold will get in, and if the car is going far enough it will freeze the contents. If there is a heater in it, see that it is burning and that it has enough oil in it to keep it going and carry it through to the next division terminal, and don't turn the wick up too high. We lately had two cases of damage to butter; it was so covered with soot and dirt that nobody would take it and we had to pay for it. We paid a large amount for damage to stuff by frost — all because this refrigerator business is not properly handled.

"We are having claims for flour damaged by wet, on account of being loaded into cars with leaky roofs. An inspection of a car should be made carefully and with a view of locating defects. There is no need of making an inspection if we do so to find everything is right. Only a short time ago a man was running a train on double track. He was on the wrong track and didn't discover it until he had run ten miles. He was the best engineer they had, but that night he worked automatically and didn't think where he was going, and a collision resulted. Frequently we make an inspection or do things in that way.

"Sacked flour, when wet, should be resacked. There is only a very little of it damaged around the edges that sticks to the sacks. The damage doesn't get inside. If any one tries to tell you a sack of flour is damaged to the extent of fifty cents or a dollar, don't you believe it. When the consignee won't take the flour and resack it, do it yourself. If you can't do it yourself, hire somebody to do it. Don't wait two or three weeks before you do it, because if you do the flour will become mouldy. It wants to be attended to right away — do it right off. Whenever we have a sack damaged in that way it amounts to about ten cents, and we usually get a claim all the way from fifty cents to a dollar and a half. Handle this flour just the same as you would handle it for yourself; then you will be all right.

"In loading wheat, corn or oats, insist upon the elevator people patching up any leaky car before it is loaded, and if one man won't do it give the car to his competitor, who will; then we won't have a continual stream of claims for grain leaking out of cars this winter. But for goodness sake, examine cars to know whether they are loaded with grain before issuing receipts for them, and make the receipts, "Shipper's load and count."

"When a shipment is delivered to us it becomes the property of the consignee; it does not belong to the shipper any more. If you get a request from the shipper or any one else not to deliver it to the consignee or to deliver it to some other consignee, don't you do it, but notify me about it, and notify me right away, because under certain circumstances the shipper has a right of stoppage in transit where he finds after the shipment has gone forward that the party has no money to pay for it or that the goods were obtained in a fraudulent manner and that is why he wants the shipment stopped. When the shipment is stopped, we must not deliver it until the dispute is settled because, if we do, it may turn out that the shipper did not have the right to stop it, and if we make a mistake in these goods we have got to pay for it. Always check packages when you make delivery, and know whether they are in good order or bad order; and you want to know that you are delivering it to the right consignee. If the consignee does not come himself and sends a drayman, the drayman must have an order.

"When you men, who handle this freight in trains, get one-half of the car unloaded, don't leave the rest of it four or five tiers high, so that the first time the car is switched the freight will be sent to the other end of the car; we aren't paid for that additional ride. Break it down, and fix it so it won't get spoiled or damaged. Handle it the same as you would your own, as if you were driving a dray. And when you have merchandise going to small stations and you don't have enough help and it is raining to beat the band, don't unload the

stuff in the rain, but take it on to the next place and bring it back next day, because the chances are if the freight is unloaded in the rain it will all be damaged. Don't put pianos under the eaves of the freight house.

"The reason a shipper has freight billed to order or notify is because he doesn't trust the man he sells goods to. The bill of lading must be endorsed. When we deliver that shipment without a bill of lading we know what happens. We are chasing the other fellow. About nine times out of ten we don't get the money. Just as long as we have the goods in our possession they will be chasing us, but the minute we deliver the goods without the bill of lading we will be chasing them, and the chances are we won't get our money. There is no reason why we should trust the consignee if the shipper doesn't. He knows more about him than we do. No matter who the man is, under no circumstances deliver the shipment to him without the bill of lading properly endorsed.

"When you load a car, take the old seals off and don't leave them there until they grow whiskers. [In this he might have included old cards of various kinds.] Put on your station seals, and when you load these cars fasten the end doors inside with a cleat. That is where our robberies occur. That is the reason we want them cleated before sending the car forward. And when you take a seal record, take the lock and seals on all the cars. That does not mean every third or fourth car, but every car that comes. Seal all cars, lime, horses, lumber, ties, posts — if there is a loss on such a car and we haven't got the seal record, we have got to pay the claim. If, however, we have the seal record and a claim has to be paid it is divided between the two roads over which it passed. And as for the vents on refrigerator cars and the doors on ice-boxes, we want a record of the doors and vents whether they are open or shut just the same as the seal record.

"If a shipment of horses is going to some place and we have poor connections, notify the train dispatcher to get the car into some train that will get it to destination, and when you do the switching don't use the car of horses for a bumping post. Don't make a flying switch with a car of horses. Don't use it next to the engine because it has a good air brake, but handle horses the same as you would babies. Handle them as if they belonged to you.

"Now I have shown you how many of the losses occur; I shall tell you how I think many of them could be avoided. 'An ounce of prevention is worth a pound of cure.' Handle the company's business the same as your own. In case of doubt always (not sometimes) take the safe course. Speed must give way to safety. Expedition in the handling of traffic must give way to accuracy. [The General Freight Agent may take a different view of it.] Read and re-read the book of rules so you will know what they are, the same as you did the first letter you got from your superior officer commending some good act you had done, or the first letter you received from your sweetheart. And when you are up against some proposition that you do not understand, and you cannot find the desired instructions or advice in the book of rules, ask your neighbor agent. If he does not know, ask the Superintendent or the proper officer."

Increased service to be obtained from equipment on a road's rails may be brought about largely by a proper loading

system and the placing of freight in the right cars. Proper points for transfer must be designated to which each individual station loads for each other station. This requires the working out of a schedule and demands knowledge of conditions, with an occasional revision as such conditions change. At each transfer station a loading program must be worked out, dovetailing into the larger general plan for the road as a whole. Another is needed for smaller stations and finally one for the conductors of local freight-trains. Much loss of freight, damage, loss of use of freight equipment, slow time and improper deliveries may result from lack of intelligent handling or improper or insufficient instruction of the local freight conductors.

Instructions should be issued to all concerned, including transfer and station agents and the local conductors, to load freight for certain large stations directly, or to certain substations or piers for territory controlled, placing a minimum for a car. If such minimum cannot be had, instructions must direct the transfer point at which to reload, and where in turn, a car may be made up, or how long the freight may be held at the originating point in order to secure a full car-load, or sufficient freight, for any destination. Freight for certain districts, including a number of smaller stations, is usually loaded to the transfer station just in advance of the territory, although in many cases, it may make better time or be more economically handled by loading it beyond its destination and arranging for its return. The general object is, of course, to get the greatest possible service out of cars with the least expense and this involves consideration, primarily, of time and mileage. While maximum load is the goal, it is not always in the interest of economy and good service to seek this blindly to the exclusion of other features. Foreign cars when not in demand, may be started homeward with a light load. In this the judgment of the individual must finally determine how long it will be permissable to hold the car for a certain lading. He must figure on the amount of per diem charges involved, the distance the commodity and the car move, the supply of cars at hand and the demand therefor, the train service, etc.

In the handling of system cars the officer in charge of car service may lay down the general proposition for the guidance of his subordinates, that in the predominating traffic direction cars should be loaded to their full capacity and worked to necessary transfer points to avoid as far as possible, any movement without full tonnage. When the predominating traffic direction changes, his instructions necessarily require revision. The traffic in both directions may nearly balance for a while, when heavy loading is desirable. In the direction opposite to that in which traffic predominates, cars may usually be loaded light and cars be forwarded to stations, with comparatively light loads, to save time and reduce handling. Time is an important element, as there is naturally keen competition for traffic in the direction in which light cars move, while the condition in the opposite direction may be such that no great effort is made to secure additional tonnage. Power or facilities may be taxed to their utmost and possibly cars in which to move the business offered may be difficult to obtain. This last contingency may again affect the methods of loading in the direction of the empty-car movement.

It may seem good practice to load cars light, or to load below the prescribed minimum to certain stations in order to save time and eliminate additional handling. If this tends to delay the movement of empty cars at a time when such cars are in demand for return loading, it becomes objectionable. To illustrate: A station of some importance on a branch line, perhaps 100 miles away from the main line, necessitates a haul of 200 miles for every car going there, from the time it leaves the main line junction until it returns. If the contents of ten or twelve cars may be transferred into four or five cars at the junction, or the regularly designated transfer in advance, it will be economy to go to the additional expense of transferring and incur the risk due to the handling in order to get perhaps two or three days' additional service out of the seven or eight cars and to save the mileage. This is an extreme case and the saving of the mileage may justify the transfer at any time — although this is dependent largely on the characteristics of the line, the distance, amount of business, fixed train service, etc.

Take the case of a station on the main line, to which a number of cars may be moving in the light-car direction, and which is located midway between division terminals and transfer points: The object is to utilize empty-car movement to the utmost by taking advantage of the light engine mileage made necessary in " balancing power." The traffic conditions may be such as to necessitate cutting these cars out at the first division terminal, awaiting the local freight of the following day, and the movement of the empties from the point where released will be by local freight, one, two, and probably three days later. On arrival at the next division terminal they again await their turn on the classification lead and move out on some following train. In such cases the unloading, consolidation and reduction of the number of cars at the first transfer point reached may be justified by the additional number of days' service to be got out of some of the cars. The saving of the per diem charges is another argument in favor of the additional handling necessary. The whole question is one requiring constant watching and changes in the program without hesitation.

The points to be studied in trying to effect economies in loading cars may be summarized as follows:

1. Loading to avoid all transfer if possible.
2. Loading to transfer farthest from originating point.
3. The avoidance of too light loading from transfers to other transfers, as it is many times more economical and time-saving to hold freight over one day and secure consolidated tonnage.
4. Consideration and action on the fact that short distances should not always govern the handling of short-line traffic, as loading to a transfer which receives and distributes from a large number of stations often warrants longer mileage to secure prompt movement of cars and freight.
5. The loading of proper cars, especially with a view to quick handling of foreign equipment.
6. Checking arrival and departure of all cars for transfers and seeing that they are promptly placed at platforms and forwarded.
7. Reporting to the Auditor of Freight Receipts delays to freight by non-arrival of waybills.
8. Careful consideration of freight-train schedules in connection with proposed transfer movements.
9. Consideration, in connection with actual experience, of the best method of forwarding in both directions L. C. L. freight to and from eastern and western divisions, laying particular stress upon improving transfers within home territory.
10. The proper storing of freight to withstand transportation.

The manager of the transfer station and the freight-house has the opportunity to contribute largely to good service and to materially reduce the cost of handling. The one great difficulty at these points is that of inducing those in charge to take a broad view of the general conditions on the line instead of confining their vision entirely to their own transfer or freight-house to the exclusion of the remainder of the line. In their efforts to reduce the cost of handling at the platforms under their immediate charge they may abnormally increase the cost at other points or along the line generally. A car to be handled by a local freight, may be badly loaded and such hurried loading at the transfer may save a few cents at that point. The rehandling or return of freight to the house and reloading or holding for another car instead of loading beyond the point of delivery and requiring its return, may cost the railroad many dollars in consuming the time of an engine and entire freight crew. The time taken in hunting for the freight wanted, unloading and reloading, damage claims resulting from exposure or additional handling at points where facilities provided are meagre, and the occupation of the main track to the exasperation of the train-dispatcher and the crews of other freight trains, are costly. This slovenly work at transfer stations and at other loading points is one of the difficult things to keep a check on and break up. One of the best remedies is a wideawake, intelligent trainmaster who unexpectedly starts out with a local freight and takes possession of all the conductors' waybills and notes the condition of the interior of each car as the various stations are reached. He will not stop at the question of loading in "station order"; method of loading; putting flour in proximity to oils or syrup barrels; safes or stoves on top of bric-a-brac; freight for points on other divisions or districts having to be rehandled and returned; but will also note the manner in which freight is being loaded at transfers on divisions over which he has no jurisdiction. Such information and any suggestions occurring to him he should convey to the officers in charge of car service.

At freight-houses, large, easily read signs should be placed at openings, indicating points for which freight is re-

ceived at such openings and freight for such destinations as go in to any one car should be kept together. Cars should have placards or numbers attached, to indicate destination or destinations, and should be placed in such position as to enable freight to be trucked into them with the least possible trucking. If a series of tracks is used with trucking or landing platforms between the cars on the tracks, one may be prefixed with the figure 1, those on the next track by the figure 2, with a hyphen following and then the order number of the car on the track, counting from one end of the house. Thus: 1-10 indicates car 10 on track 1 and is for New York loading. A painted signboard or "flag" box is hung on this car, lettered "1-10," and all freight for it is marked "1-10" with a crayon, or a card accompanies it, bearing that number according to the system employed. The so-called "return ballot" system requires a trucker to go into the car, deposit his freight and take from a hook inside the car one of the checks marked "1-10" and return it to the checker who loaded the truck.

Another system to insure loading freight into proper cars and prevent its going astray requires the use of a checking machine and booth for each checker, and has been successfully used, especially at stations and piers where shipments originate. The trucker passes the checking machine and presses a lever which throws out a card giving the "flag" number of the car into which the freight is to be placed and a consecutive number for tracing purposes. The same movement also stamps the waybill and adds the date on its face. The trucker deposits his check in the "flag" box on the outside or on the door of the car. These boxes are kept locked while the cars are being loaded. After the day's loading has been completed the agent or his representative unlocks the boxes and goes over the checks. If any checks are in the wrong boxes it indicates improper loading and by a reference to the waybills the freight, etc., with destination may be located and by wiring the first transfer point or station at which the car containing the stray shipment stops, the freight may be recovered and started in the right direction. At some stations the "flag" box of the checking system without the machines has been used. The

trucker is given a check for each load, bearing the " flag " box number, which he deposits in the locked box and an inspection afterwards will reveal if any stray freight is in the car. The tracing however, is somewhat more complicated.

Many freight and transfer stations are introducing, with varying success, the system of handling freight and paying for it on the tonnage basis — an application of the " piece work " system. The success of this method and the details for working it depend largely on the class and cost of labor and the kind of commodities handled. There are various methods under which this may be worked; among others is that of taking a careful record of the handling of the freight and figuring on the cost per ton. One rate is usually made for package freight and another for carload or bulk freight. At times other rates are made for certain kinds of commodities which run heavily. A record is then kept of the number of tons handled by each laborer. In some cases the men pool the work and the amount is paid in a lump sum to the foreman or leader of the gang employed. The work may also be let out on the contract basis at a stipulated rate per ton to the foreman or contractor who in turn makes his own bargains with the laborers. No attempt should be made to materially lower the actual cost of handling. The company's advantage consists in securing fewer and better men and in eliminating the labor agitator or disturber. It also results in quick handling of freight, as the men will hurry or work over-time when necessary. In practice it has been found that the cost per ton is quite like the rate of wages, per hour, paid the freight-handlers.

The use of a rubber stamp, to stamp on each package received, the date, approximate hour and car from which unloaded, has been the means of securing the delivery of many pieces of freight that would otherwise have found their way into the pile of unclaimed freight, and, later, into the " old hoss " sale. Many packages may be traced to an originating point in this way, where the entire absence of marks would otherwise indefinitely " sidetrack " it.

A convenient and simple arrangement for directing teamsters to their cars, is a blackboard, near the team yard

delivery clerk's office, upon which all the loaded cars in the yard are entered after the yard has been worked. The track numbers, and occasionally the position on the track, is also shown. The teamsters consult this board and drive directly to their cars without being delayed or compelled to ask questions.

The Chicago & North-Western has in operation in its Chicago freight-houses a method of loading and unloading l. c. l. freight which has been worked out in minute detail. The principal freight houses are at State street, Grand avenue, Wood street and 16th street. The State street house receives from and ships to the Galena division, and the Grand avenue house, from the other two divisions. Wood street is a transfer freight house for freight to and from connecting lines delivered in cars, and Sixteenth street for connecting line freight for the North-Western delivered by teams. The mixed freight (except perishable) from the road for connecting lines received at Wood street is there distributed into the proper foreign cars. Practically the only freight for Chicago received at either Wood street or Sixteenth street is in carload lots for delivery on near-by team tracks.

The State street "out" freight house loads cars for all points on the North-Western Line, large deliveries in l. c. l. lots being made at the house daily by teams. Five tracks of 18 cars each are loaded at a time. Each five cars opposite each other are called a "run" and are in charge of a stevedore, who is entirely responsible for correct loading. To make his responsibility complete, freight is not wheeled into the cars by the truckers. They leave the loaded trucks on the freight house platform just outside the door of the first car in the run. Then as the stevedore takes each piece of freight into the car himself, all mistakes in loading can be traced directly to him. It is also his business to examine each piece of freight for its actual destination instead of depending on the marker's chalk marks which are intended solely for the direction of the trucker. For instance, if his run was number 4 (*i. e.*, the five cars each of which is fourth on its track) and the car on the third track was a straight car for Minnesota Transfer,

he must be sure that each piece of freight that goes into that car is really destined for points on connecting lines beyond St. Paul and Minneapolis and not simply that it is marked "3-4" (third car on fourth track).

New York, Boston, Philadelphia, West Albany Transfer, Buffalo, Cleveland, Pittsburg, Alliance, Columbus, Ft. Wayne Transfer, the Erie Despatch, Lackawanna Despatch and Merchants Despatch Transportation Co. are among the eastern points and fast freight lines which load straight cars for Wood street. These cars must contain nothing but freight for points beyond Chicago on or via the Chicago & North-Western. A mixed car, for instance, containing merchandise, part for some point on the Chicago & North-Western, the rest for Grand avenue or State street, Chicago, would be returned to the connecting line for proper loading. Straight cars from connecting lines are switched at Wood street to the proper westbound track for handling by transfer trains. Foreign cars of mixed freight are run into the freight house from the east end on a track running through the center of the house. They are then unloaded and their freight reloaded into cars for the road, those from the Galena division being on the four tracks at the north side of the freight house and those for the Wisconsin and Milwaukee divisions on the four tracks at the south side. As the front cars in the house are emptied, the whole line is pulled through, the empty cars detached at the north end of the line and the whole process gone over again. If it is necessary to unload more connecting line cars at once than the number which this track inside the freight house will hold, extra cars may be unloaded at the south end of the house, where there is a platform 30 cars long. About 125 cars of such mixed merchandise freight are received daily from connecting lines. Some 60 or 70 of these cars are daily sent back to their home roads after having been loaded with connecting line freight which comes in mixed cars from points on the North-Western Line. These mixed cars from the road are unloaded on platforms at the east end of the house.

The accompanying loading plan shows the arrangement of cars loaded for the road at Wood street. Each numbered

space represents a car. Runs 1 to and including 14 on tracks 1 to 4 inclusive are on the north side of the house and are cars for points on or via the Galena division. Runs 16 to 31 are on the south side of the house and are cars for the Wisconsin and Milwaukee divisions. As will be seen from the chart, most of the cars are way or "peddler" cars which run on through trains to the beginning of their respective territories and over their territories on way freight trains. On these cars it is, of course, important that freight for the first station in

CHICAGO & NORTH WESTERN RAILWAY
WOOD STREET STATION. ______________190

TRACK ONE				TRACK TWO				TRACK THREE				TRACK FOUR							
Run	Station	Box	Car No.	Run	Station	Box	Car No.	Run	Station	Box	Car No.	Run	Station	Box	Car No.	Run	Station	Box	Car No.
1	AUSTIN TO OAK PARK	1		1		2		1	KELLY TO DES MOINES	3		1	OGDEN	4		1			
2	RIVER FOREST TO CORTLAND	5		2	SYCAMORE AND DE KALB	6		2	MARSHALLTOWN AND IOWA CENT.	7		2	U. P. TRANSFER	8		2			
3	ELVA TO SPRING VALLEY	9		3	NACHUSA TO MALTA	10		3	CEDAR RAPIDS	11		3	SAN FRANCISCO	12		3			
4	TERRA COTTA TO WILLIAMS BAY	13		4	DIXON	14		4	CLINTON OIL	15		4	SACRAMENTO	16		4			
5	DUNDEE TO ALGONQUIN	17		5	STERLING	18		5	CLINTON TO LUZERNE	19		5	POCATELLO	20		5			
6	ELGIN	21		6	FULTON TO LIMESTONE	22		6	BOONE TO GLIDDEN	23		6	U. P. TRANSFER	24		6			
7	PECATONICA TO WAYNE	25		7	[illegible]	26		7	[illegible] AND BELLE FOURCHE	27		7	PORTLAND	28		7			
8	FREEPORT & RIDOTT	29		8	MASON CITY TO [illegible]	30		8	[illegible]	31		8	PORTLAND	32		8			
9	ROCKFORD	33		9	[illegible]	34		9	[illegible]	35		9	COLORADO	36		9			
10	BELVIDERE	37		10	[illegible]	38		10	[illegible]	39		10		40		10			
11	BATAVIA	41		11	[illegible]	42		11	[illegible]	43		11		44		11			
12	AURORA AND NO. AURORA	45		12	[illegible]	46		12	BLAIR TO BORDEAUX	47		12		48		12			
13	GENEVA AND ST. CHARLES	49		13	[illegible]	50		13	OMAHA, Via Blair	51		13	LYONS TO ANAMOSA	52		13			
14	WEST CHICAGO	53		14		54		14	COUNCIL BLUFFS	55		14	PEORIA	56		14			
15		57		15		58		15		59		15		60		15			
16	NO. CHICAGO & WAUKEGAN	61		16	WOODSTOCK TO HARVARD	62		16	[illegible]	63		16		64		16			
17	[illegible]	65		17	WIS. DIV. OIL CAR	66		17	OSHKOSH TO NEENAH	67		17	POWERS TO MICHIGAMME	68		17			
18	NO. EVANSTON TO ZION CITY	69		18	MINNEAPOLIS	70		18	APPLETON TO GREEN BAY	71		18	MILTON JCT. TO OAKFIELD	72		18			
19	KENOSHA	73		19	MINNEAPOLIS	74		19	MILWAUKEE	75		19	KIRKWOOD TO GALESVILLE	76		19			
20	RACINE JCT	77		20	ST. PAUL	78		20	MILWAUKEE	79		20	SPARTA TO LA CROSSE	80		20			
21	RACINE	81		21	ST. PAUL	82		21	MILWAUKEE	83		21	[illegible]	84		21			
22	DEERING TO EVANSTON	85		22	[illegible]	86		22	MILW. NORTH	87		22	WINONA	88		22			
23	[illegible] HARBOR TO SO. MILWAUKEE	89		23	DULUTH	90		23	MILW. WEST	91		23	WINONA TRANS.	92		23			
24	MINN. TRANS. G.N.	93		24	WEST SUPERIOR	94		24	SHEBOYGAN TO PLYMOUTH	95		24		96		24			
25	MINN. TRANS. G.N.	97		25	HUSTLER TO ALTOONA	98		25	LAKE SHORE JC TO KIMBERLY	99		25	SUGAR BUSH TO MARSHFIELD	100		25			
26	MINN. TRANS.	101		26	JANESVILLE	102		26	FOND DU LAC	103		26	BIRNAMWOOD TO ASHLAND	104		26			
27	MINN. TRANS.	105		27	BELOIT	106		27		107		27	[illegible]	108		27			
28	MINN. TRANS.	109		28	CALEDONIA TO BARABOO	110		28		111		28		112		28			
29	MINN. TRANS.	113		29	HIGHWOOD & LAKE FOREST	114		29		115		29		116		29			
30	CUDAHY	117		30	HIGHLAND PARK	118													
31		121		31		122													
32		125																	

FIG. 36 — Loading Chart for Wood Street Freight House.

the peddling territory be loaded next the door. Straight cars on the other hand such as the one for Elgin, Run 6, Track 1, or the nine for points west of Omaha, Runs 1 to 9, Track 4, are loaded with no care for any special arrangement inside the cars. The "runs" are the same as at State street, but instead of marking with chalk on a box of freight destined for Elgin, "6-1," as would be done there, the trucker is given a ticket which would be filled out in this case: Run No. 6, Box No. 21. In each car is hung on a nail a tin box with a num-

ber on it. The box in the Elgin car is box No. 21, because counting from the first car on the first track and across and so on down it is the 21st of the Galena division cars. Similarly Run 17, Box 67, is a way-car from Oshkosh to Neenah over the Wisconsin division, and is the second car on the third track south of the house and, counting in the way described, the 67th car from the first car on the first track of the Galena division.

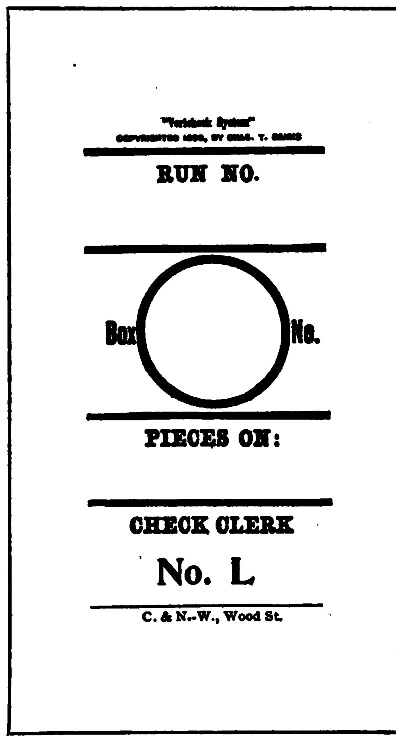


FIG. 37 — Trucker's Ticket Used at Wood Street Freight House.

The unloading of each foreign car on the track in the center of the house is done by a gang of seven men, a checker, caller and five truckers. The checker makes out a ticket for each piece of freight as it is brought out of the car. This the trucker takes along with him and drops into the box of the designated car when he deposits the freight in that car. Before the train leaves for the road, an inspector goes into each

car and examines all tickets in order to see that there are none in any box except those which belong there. There is a stevedore for each " run " who, although he does not himself truck the freight into the cars as at State street, is responsible for its being in the right car and for its arrangement in the car. The weight of each piece in each car, taken generally from the waybill or as weighed when taken out of the foreign car, is recorded on a slip by a clerk in the office and the total tonnage unloaded from that car recorded to the credit of the gang which did the work. Instead of being paid by the hour, as at State street, the check clerks, callers and truckers are paid on a tonnage basis, the amount actually handled from each car being credited each to the checker and the caller and divided among the five truckers. There is a minimum day wage which is paid in case the tonnage payment falls below that amount, but this seldom happens. The system is said to have worked most satisfactorily both to the company and to the men. The same system has not been applied at any of the other freight houses because at all of them, freight is received by teams and by collusion between truckers and teamsters some men would be able to make large earnings on the tonnage basis by getting all the heavy freight to carry, while others would handle only light freight and would make correspondingly low wages. At Wood street the freight is trucked just as it comes from the cars and each set of truckers has exactly the same chance.

The 103 cars designated on the loading chart are the very least number of cars for the road which are loaded in any one day. The average at Wood street is about 130 cars per day. The extra cars not designated on the chart (most of which are usually " straight " cars, for instance extra cars for San Francisco or Minnesota Transfer) are set for loading on the tracks in places represented by the blank spaces on the chart or on available tracks at the east end of the freight house.

For computing train tonnage it is necessary to know the weight of the loaded cars. There is not time to make this up from the waybills and mark it on each car before leaving. It is necessary, therefore, to get a working average for the weight

of a loaded car. In order to do this a record is kept each month of the weight of all cars, loaded at Wood street and the average weight computed at the end of the month. This is used as a unit figure during the following month. For instance, during July the average weight of a loaded car was found to be something over 45,000 lbs. The nearest number of even tons were therefore adopted as the unit, and during August all train tonnage was reckoned on the basis of 23 tons for each loaded car. This is on the basis of 17 tons for the weight of the car and six tons for the weight of the merchandise in the car. If during August the average recorded weight of all cars loaded for the road rose to over 47,000 lbs., 24 tons per car would be the working basis during September. Refrigerator cars are rated two tons heavier than the working figure, this amount extra being allowed for the weight of the tanks.

There are daily shipped west over the Chicago & North-Western from Wood street from 15,000 to 20,000 pieces of merchandise. A careful record shows that the mistakes in loading amount to at most one-tenth of 1 per cent., or about 15 out of the 15,000 to 20,000 pieces handled. This is quite remarkable in view of the fact that merchandise received at Wood street comes out of foreign cars indiscriminately instead of as at freight houses used by the public where it is delivered at the most convenient door by a teamster who knows the arrangement of the house and the destination of his goods and who keeps his shipments separate for loading.

At 5 p. m. the "boxes" are taken out of the loaded cars, the doors are closed and sealed and the cars are ready for the road. The connecting line cars are closed at 6 p. m. In addition to the road cars loaded in the house, solid cars loaded on near-by team tracks go out of Wood street.

CHAPTER XVII

Making Up Trains

The first destination of a car is governed by its contents and the loading program. Arbitrarily, cars equipped with air-brakes in working order must be placed ahead. The general practice of getting trains out of terminals, as a matter of convenience to that particular terminal alone and without regard to the safe movement over the line to the next terminal, cannot be condemned too severely, unless extreme haste compels it. The work duplicated at the following terminals and the loss of time along the line, with the corresponding increased switching service are some of the effects of permitting this kind of work. There are cases where the facilities at one terminal are inadequate and a part of its work must be shifted to another. Lack of system is pernicious and unbusiness-like.

Trains should be made up to go to single destinations as far as practicable; but this frequently entails a too long wait for the necessary number of cars at the starting terminal to get a solid train. Where single destinations are impracticable, trains should be made up to run to the most distant breaking-up terminal possible. The subsequent saving in time and work will justify a considerable detention at the originating terminal. The limitation is apt to be the needs of the consignees.

Following out this general plan, it is to be expected that a few of the cars in such through-trains will " fall by the wayside " because of hot journals, broken trucks and other car disabilities. Where these cars cannot be got ready to go forward in the same train, without undue detention, arrangements should be made to forward other cars for the same destination in their places. In the absence of such cars, those for a divisional terminal may be added, to enable the full tonnage rating to be maintained, unless the direction is that of light traffic, but they should be so placed as to permit of their removal without delay or unnecessary switching. The distributing trains for the division and the local freights are

supposed to be made up in "station order," with first cars to be set off next to engine, and so on, but in trying to do this difficulties are again encountered preventing a strict compliance, by reason of the air-brake law, and the arbitrary rulings as to placing of certain commodities and certain kinds of cars in certain positions in the train. Where a train is not composed of air-brake cars throughout, the nearest approach to the "station order" make-up places the cars to be set off at the first station or siding reached at the point in the train where the air and non-air cars connect, in such a manner as to keep together all cars for the first set-off. If the train is made up of all air-brake cars those for the first siding will of course be placed next the engine. For the second set-off point, if all are air-braked, the cars should come in regular order following the engine. If the train is made up partly of non-air cars they should be placed with air-brakes just ahead of the first set-off cars and non-air cars just behind.

The cars containing the "break-bulk" or platform (L. C. L.) freight are usually placed next to the caboose, although practice varies considerably in this respect. In a heavy local run, in districts where the track occupation is dense, this plan possesses considerable merit. The front part of the train may be engaged in doing the switching for the station and industries, while the platform cars are placed alongside the freight house and being worked at the same time. Where the conditions alluded to warrant it, many trainmen may, in this manner, be worked to advantage.

It is considered good practice to handle live stock at or near the front end of the train, to reduce the shock, and to facilitate the quick delivery on arrival at destination. Loaded oil tanks, and cars containing oil, spirits or other inflammable commodities and explosives are preferably handled in the middle of the train and it may be required that a certain number (minimum 5) of cars containing other freight be placed ahead and behind, to reduce the danger of fire in case of a head-end or rear-end collision. Empty or loaded flat cars, empty oil tanks and, at times, empty or loaded gondolas with low sides are required to be kept at the rear end to minimize

liability of such cars having their bodies broken in two; especially when handled in long trains partially air-braked. This precaution is hardly necessary with the modern heavy capacity steel flat and gondola cars as they will withstand a more severe shock than wooden box cars. Passenger cars on freight trains should be kept at the rear end to avoid damaging platforms and straining their longitudinal framing. A general rule to keep the loads ahead and empties in the rear, is an old and good one. There is some difference of opinion as to the merits of one of the claims made in its favor; that trains made up in this manner pull easier. In some dynamometer tests no difference was observed. Trains made up with loads ahead are less likely to part, on hilly or "choppy" roads, and there is reduced liability of damage to equipment, and contents, where the slack runs in and out in making stops. This shock is more severe on partially air-braked trains. With the enactment of the safety appliance law, requiring 75 per cent. of the cars in a freight train, as a minimum, to be equipped with working air-brakes, what was already a very difficult and complicated question in train make-up is now far more difficult and, at times, one that cannot be met without endangering the safety of the train or seriously retarding the movement of freight. In this the good judgment of men is needed. The best must be made of a bad situation until such time as all cars are equipped with air-brakes, and air-testing and repair plants, accompanied by a rigorous inspection and repairs are more generally in vogue.

It is difficult to keep car doors closed on empty cars. Aside from the physical effort required to close many doors, the conductor generally thinks that the open door is the natural symbol for an empty car. When men are disciplined for moving empties as loads and *vice versa,* it is perhaps not surprising that this view is taken. This appeals more forcibly when a conductor and one brakeman are handed cards for 90 or 100 cars and told to clear the yard in ten minutes. Tramps will more readily board trains containing cars with open doors and there is greater liability of losing doors along the road when open than when closed and latched or hasped. A door

partly open, in falling off may cause considerable damage to property and serious personal injuries have been inflicted on double-track roads and along passing tracks where freight-car doors scraped the sides of passenger trains. There is more resistance in a train of empty box cars with open doors, due to the wind or air resistance and there is an opportunity for fire in the car, started by sparks from the engine. Perhaps 90 per cent. of freight cars have doors which open by moving to the left, in the car door run-way, as the car is faced from the outside. In a moving train, therefore, the doors on the left side are more liable to open because the stops tend to move the doors forward. The doors on the left side are consequently more likely to spread out or fall off than those on the right side.

Some roads, as a matter of convenience, or because of peculiar local conditions, continue to load their road engines according to the number of "loads" for which the rating is made. Two empties are then rated as one load. The best results are obtained where the tonnage rating is used and with this a uniformity of loading is secured that at once increases the average train load and improves the general train movement. A record kept by one trunk line of a large number of freight trains showed that 2,000-ton trains ran all the way from 27 to 65 loads; the lesser number being a train consisting entirely of steel coal cars of 100,000 lbs. capacity, loaded to 10 per cent. in excess of marked capacity. This, in itself, will indicate the unfairness of the method of rating engines on a car-load basis, and the unsatisfactory results to be obtained therefrom.

A satisfactory tonnage rating system must make allowance for lightly loaded cars, for empty cars, and weather conditions. The rating should, in the first instance, be made to fit average conditions. Actual service tests form the best basis, but the mistake is frequently made of selecting an engine in the best order, a picked crew, special attention by train dispatchers, good weather and daylight runs. When it is attempted to haul this maximum tonnage over the heaviest grades, under adverse conditions, such as bad track, heavy head or side winds, low steam pressure due to poorer coal than usual, the

train is stalled. The yardmaster is the controlling factor and he must combat temptation to overload engines merely to open or clear his yard for the time being. Trains move with more difficulty during the night.

An economical tonnage rating is estimated by one authority to be 80 per cent. of the maximum available drawbar pull, under favorable circumstances. This may be determined by the use of a dynamometer car and should be confirmed by service tests. On one division of a large road it was claimed that by dropping from the full maximum rating of 100 per cent. to an 80 per cent. rating for comparative months in two consecutive years, the tonnage per engine mile was increased 13 per cent., and per train mile 16 per cent., with a decrease of 9.3 per cent. in coal consumed per ton-mile. If these figures are correct they can only be explained by the large number of cars set off with the higher rating by stalled trains.

Two essential factors enter into the theoretical rating of trains; the power of the locomotive to draw its train, *i. e.*, the tractive power exerted at the drawbar in the rear of the tender, and the resistance of the train.

The theoretical drawbar pull may be found by the formulæ arranged in the following table:

TYPE	TRACTIVE POWER OPERATED SIMPLE	OPERATED COMPOUND
Single Expansion	$\frac{.8\ Pd^2s}{D}$	
Two-cylinder Compound	$\frac{.8\ Pd_H{}^2\ s}{D}$	$\frac{.8\ Pd_L{}^2\ s}{(R+1)\ D}$
Tandem Compound	$\frac{1.15\ Ps}{D}(.66d_H{}^2 + .25d_L{}^2)$	$\frac{Ps}{D}(.66d_H{}^2 + .25d_L{}^2)$
Baldwin Compound	$\frac{1.8\ Pd_L{}^2\ s}{(R+1)\ D}$	$\frac{1.7\ Pd_L{}^2\ s}{(R+1)\ D}$
Four-cylinder Compound	$\frac{1.6\ Pd_H{}^2\ s}{D}$	$\frac{1.6\ Pd_L{}^2\ s}{(R+1)\ D}$

P = boiler pressure in lbs. per sq. inch.
d = diameter of cylinder in inches.
s = stroke of piston in inches.
D = diameter of driving-wheels in inches.
d_L = diameter of low-pressure cylinder in inches.
d_H = diameter of high-pressure cylinder in inches.
R = ratio of cylinder volumes.

The resistance of a train can only be approximated since too many indeterminate factors enter into the calculation to enable any accurate computation to be made. One or more heated journals, for example, will have an appreciable effect on resistance. One of the simplest and most reliable formulæ used is:

$$R_e = 3.5\ T + 50\ C.$$

R_e = resistance of train in lbs. on level tangent at 10 m. p. h.
T = weight of train in tons of 2,000 lbs.
C = number of cars in the train.

If a train is drawn up a grade at the same speed the resistance per ton due to the grade is:

$$R = \frac{2000}{5280} \times \frac{5280}{100} \times \text{rate of grade in per cent} = 20 \text{ lbs. for each 1 per cent.}$$

For a grade of 1 per cent. the formula for total resistance becomes:

$$R = 23.5\ T + 50\ C.$$

Curve resistance is variously estimated by Wellington at from 0.33 lbs. per ton per degree of curvature with track and equipment in good condition to 1 or 1.5 lbs. per ton per degree with track in bad condition. Velocity also affects curve resistance. On a 1-deg. curve the resistance at 12 m.p.h. was found to be 1 lb. per ton and at 22 m.p.h. to be only 0.5 lbs. per ton. Curves are usually compensated by adjusting the grade so as to make the resistance no greater than on a tangent.

The arrangement of loaded and empty cars in the front or rear of the train also affects train resistance. Mr. J. M. Daly in a paper read before the New York Railroad Club, October 20, 1905, estimated the resistance when heavily loaded cars are placed in the rear of the train and empty cars in front at 10 per cent. greater than when the loaded cars are placed in the front end of the train. Assuming the resistance of a loaded car in the head of the train as a basis it is undoubtedly true that as the car is placed in consecutive positions farther back in the train the resistance increases in small proportional amounts.

Many formulæ have been proposed for calculating the tonnage rating of locomotives, some of them simple and only fairly accurate and others complex and more difficult of ap-

plication but for which greater accuracy is claimed. Mr. J. M. Daly of the Illinois Central has perfected a machine resembling a cash register somewhat, which automatically adjusts the tonnage rating for light and loaded cars in any position in the train. It is claimed that the machine prevents over or under-loading of engines resulting from hurried or careless computation of tonnage rating in the yardmaster's office and that it saves a great deal of time in making up trains of the proper weight. Nearly every road now has in use some formula for tonnage rating derived partly from theoretical calculations and partly from observed data with a dynamometer car.

Whatever formula for tonnage rating may be in use, it should be intelligently applied. Necessary reductions in tonnage rating must be made when conditions on the road are abnormal. An overloaded engine may be a source of greater loss in operating than an underloaded engine. Yardmasters should anticipate as far as possible a sudden fall in temperature, high head winds or side winds, snow, sleet, rain and fog and load engines starting out from the terminal accordingly. A rail is in worse condition after a slight rainfall than after a heavy rain which clears it of all grease and oil.

On many roads a reduction of from 5 to 10 per cent. in the tonnage rating is made for wet rails and 10 to 15 per cent. during the winter season. On one road train dispatchers are instructed to reduce the normal tonnage rating 5 per cent. when the themometer falls to freezing, 32 deg. Fahr., 10 per cent. when below 20 deg., 15 per cent. when between 15 deg. and 10 deg., 20 per cent. between 10 deg. and 0 deg., 30 per cent. between 0 deg. and —10 deg. and 40 per cent. when below —10 deg. Reductions are also made by request of the division master mechanic for engines in bad condition and for engines just out of the shop being broken in.

The effect of journal lubrication on train resistance is important. The New York Central instructions for packing journals were issued with a view of securing more economical, uniform and efficient work in this detail. They are as follows:

"In packing boxes, the first portion of waste applied is to be wrung moderately dry, and it is to be packed moderately tight at the

rear of the box, so as to make a guard for the purpose, not only of retaining the oil, but excluding the dust as well. Care is to be taken to keep the waste at the side of the box down below the bottom of the journal bearing about an inch, and also to have that portion of the waste in the front end of the box separate and distinct from that which extends from the front end of the journal to the back of the box. This will avoid derangement of the packing in the rear of the box.

"The roll of packing which is placed in front of the box is not to extend above the opening in the front.

"At terminals or yards where journal boxes require special attention to the packing, the following practice is to be adopted:

"A packing knife or spoon of standard style should be used. This packing knife or spoon is to be used to ascertain whether the packing is in the proper place at the back of the box, and to loosen up the waste at the side and rear of the journal. This particular treatment is given to prevent glazing of the packing (which occurs when it is too long in contact with the journal) and, at the same time, to put the packing in the proper place at the rear of the box. It is desirable to give this treatment at intervals of 500 miles run for cars and tenders, if possible.

"A small quantity of packing is to be removed from the sides of the journals when found not in good condition, and this replaced by a similar quantity of well-soaked packing. No box is ever to have oil applied before the packing is properly loosened up on the sides and back of the box with the packing iron. Before applying a bearing to a journal, the surface of the bearing is to be examined to insure that it is free from imperfections of any kind that will cause heating. The surface of the bearing is then to be oiled or greased before it is placed on the journal. When applying wheels or axles, the journals are to be examined to insure their being free from imperfections which would cause heating. When wheels or axles are carried in stock, the journals should be protected with a good material suited to protect the surface, without hardening, and one which is not difficult to remove.

"When the journal is found heated and there is a good supply of packing in the box, it is evidence of some imperfection of the journal, journal bearing, box or wedge, and the bearing is to be removed, provided the box is heated to such an extent as to require repacking of the box. Boxes which have been warmed up slightly will in most cases, by partially replacing with freshly soaked packing, give better results than by entire removal of the packing from the box. When it is necessary and permissible to oil boxes, it shall be as short a time before leaving-time of the train as possible.

"When preparing packing, the dry waste is to be pulled apart in small bunches, and any hard particles in it removed. Each bunch is to be loosely formed to facilitate soaking and packing, as in this form boxes can be packed in a more satisfactory manner and with less waste of oil. This loose, dry packing is to be put in soaking cans or tanks provided for that purpose, pressed down moderately tight, then covered with oil and allowed to remain 48 hours. After being saturated for that length of time, the surplus oil is to be drained off, leaving it thus in proper condition for packing boxes. Standard equipment for saturating and draining packing is to be provided at all points where packing is to be kept for use, unless suitable equivalent equipment is already in use."

The yardmaster should be familiar with these and other rules governing car inspection. The author has usually found that the yardmaster and his assistants exert a greater influence over the inspectors and car repairers in inducing them to do their work quickly and properly than do those who have these men under their direct charge. The yard men are the greatest sufferers by any delay or improper work on the part of the inspectors and car repairers.

CHAPTER XVIII

Fast Freight

Fast or preferred freight includes live stock, perishables, merchandise and other high-class freight taken at higher rates and classified to have precedence in time over common through and local freight.

It is estimated generally that "live stock, perishables and merchandise" include about 10 per cent. of the entire freight traffic; 30 per cent., however, will be the proportion when the high-class freight at higher rates is added. It would be interesting to know the cost of handling fast freight in excess of ordinary freight but, unfortunately, accurate statistics on this point are hard to obtain. Some carefully conducted tests were made and records kept of the cost of moving trains at various speeds, some years ago, on the Northern Pacific.

On the Minnesota Division, westbound, at a speed of 15 miles an hour with an engine developing 400 h.p. and hauling 1,050 gross tons, the cost per train mile was 60 cents. At a speed of 20 miles an hour the tonnage is reduced to 949 tons and the equivalent train mile cost increased to 68.6 cents. At 25 miles an hour, tonnage 631 tons, cost per train mile $1.067. At 30 miles an hour, tonnage 431, cost $1.745 per train mile. At 35 miles an hour, tonnage 304, cost per equivalent train mile $2.743. At a speed of 35 miles an hour, it cost four and one-half times as much to move an equivalent tonnage as at 15 miles an hour over this particular division of road. Additional track maintenance, loss of time to ordinary and local freights in clearing the line for fast freights, are some of the elements of cost which are not included in the above figures.

Another interesting and instructive series of records were kept to collect data on the relative economy of running slow freight-trains with engines loaded to maximum capacity, compared with fast-freight trains of less than the maximum capacity of engines, on the Indiana Division of the Baltimore

& Ohio Southwestern during the months of January and February, 1904. The records and results obtained were as follows:

First. — For common freights scheduled to travel about nine miles an hour, rating being assumed as full capacity of engine for this speed.

Second. — For semi-quick despatch freights, it being intended that this class of freight should make an average schedule speed of 15 miles an hour, rating of engines being assumed at 72 per cent. of rating for common freights.

Third. — Quick despatch freights, it being intended that this class of freight should make an average schedule speed of 19 miles an hour, rating of engine being assumed at 60 per cent. of rating for common freights.

The data collected for each of these classes of trains for separate trips was as follows:

1. Temperature.
2. Number of engines.
3. Number of cars.
4. Number of 1,000 ton miles, no arbitrary allowance being included.
5. Running time between terminals.
6. Rate per hour.
7. Total time between terminals.
8. Rate per hour.
9. Cost of operation.
10. Cost of fixed charges.
11. Total cost.
12. Cost per 1,000 ton miles.
13. Per cent. hauled of the maximum rating for common freight.

The "cost of operation" for each trip was obtained from actual cost of wages, overtime, cost of helper engine and fuel, as shown by records of that trip; the number of engine miles per trip multiplied by the total cost per mile, as shown by monthly records for the following items; running repairs, classified repairs, oil, sand, waste, miscellaneous engine supplies and roundhouse attendants, which amounts to 14 cents per mile for the 1,500-class engines and 8 cents per mile for the 100-class engines.

The average original value of the 1,500-class engines was estimated at $11,000 each and that of the 100-class engines at $9,000 each. An annual allowance of 5 per cent. on the value should be made for interest and 5 per cent. for depreciation, making a total of 10 per cent. per annum. In order that the use of an engine may be justified, it must earn 10 per cent. per annum on the capital invested, and must for each hour of its time be worth a proportionate amount to the railroad company. For the 1,500-class engines this would equal about 12 cents an hour and for the 100-class engines 10 cents an hour. This is the fixed charge made against each train for each engine for each hour in transit. The average value of a freight car was assumed to be $800, and on the same basis a car, in order that its use may be justified, must earn 10 per cent. of its value per annum, which would amount to 1 cent per hour. On this basis the fixed charges for the train equipment for any trip would be 1 cent multiplied by the

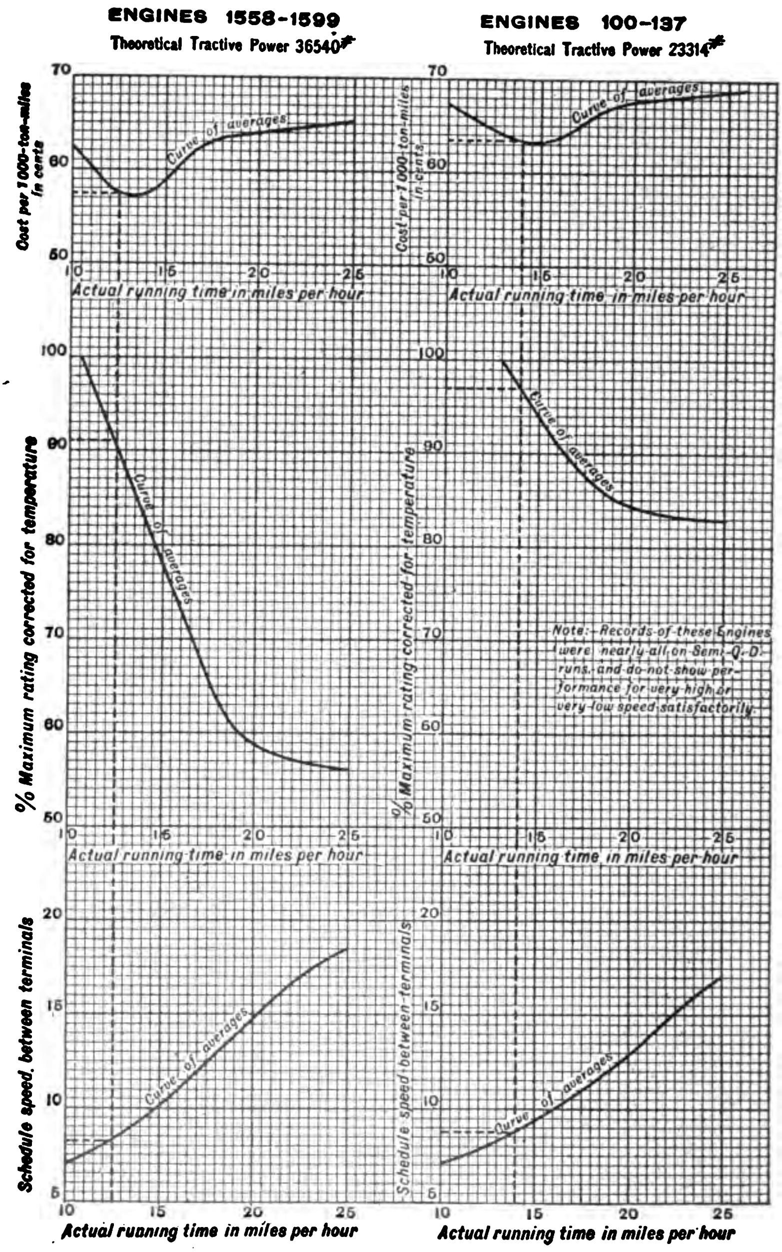


Fig. 38 — Curves Showing Relative Economy of Train Loading.

number of cars in the train, multiplied by the number of hours between terminals; plus $0.12 or $0.10 multiplied by the number of engines, multiplied by the number of hours between terminals.

The per cent. of rating handled by each train was obtained from a tonnage statement, by dividing the actual ton-mileage made by the ton-mileage which would have been made had maximum common freight rating, corrected for temperature, been used.

The "total cost" used does not represent the actual cost of handling the train between terminals, but includes only those principal items which vary with, or are dependent upon, each trip. The cost obtained by dividing the total cost by the number of 1,000 ton miles is therefore correct for comparative purposes only.

The above data have been shown graphically on the diagram as follows:

First. — A chart has been made by plotting the actual running time in miles per hour on the horizontal ordinate and the cost per 1,000 ton miles on the vertical ordinate. The curve of average results indicates the cost per 1,000 ton miles corresponding to given speeds in actual running time.

Second. — A chart has been made by plotting the actual running time in miles per hour on the horizontal ordinate and the percentage of the maximum rating for common freight on the vertical ordinate. The curve of average results indicates the percentage of maximum rating which must be given trains in order that their average speed may be a certain running time in miles per hour.

Third. — A chart has been made by plotting the actual running time in miles per hour on the horizontal ordinate and the time beween terminals in miles per hour on the vertical ordinate. The curve of average results indicates the relation between the actual running time and the schedule speed in miles per hour between terminals.

From these charts we may see graphically the comparative cost of fast and slow freight service and to a certain extent the relative economy of heavy and light motive power. When it is desired to move freight between given points on this division in a fixed time it will be possible from these diagrams to determine the rating which must be given engines in order that they may make the desired schedule.

For the 1,500-class compound freight engines the minimum cost is found at a speed of 13 miles per hour, which requires a rating of 88 per cent. of the maximum; but a speed of 12½ miles an hour does not increase the cost of handling appreciably and will allow 91 per cent. of the maximum rating to be hauled. By referring to the third chart is appears that an actual running time of 12½ miles an hour corresponds with a schedule speed of 8¼ miles an hour between terminals.

For the 100-class engines the minimum cost is shown at a speed of 15 miles an hour, which requires a rating of 94 per cent. of the maximum; but a speed of 14 miles an hour does not increase the cost of handling appreciably and will allow 97 per cent. of the maximum rating to be hauled. It also appears that a running time of 14 miles an hour corresponds to a schedule speed of 8¾ miles an hour.

From the conditions existing when these records were taken, we should conclude that for the 1,500-class engines the most economical operation will be attained by trains scheduled at 8¼ miles an hour, running 12½ miles an hour and hauling 91 per cent. of maximum

common rating. For the 100-class engines the greatest economy of operation will be attained by trains scheduled to 8¾ miles an hour, running 14 miles an hour and hauling 97 per cent. of maximum common rating.

The records of about 500 trains given above were taken during a period of exceptionally heavy traffic and also during unusual severe weather, with the temperature in the neighborhood of zero for weeks at a time. It is probable that results in warm weather would be different. It would, therefore, be desirable to make the same determinations under summer conditions. The determination of the most economical tonnage rating by this method is independent of the rating originally assumed.

To operate fast-freight service successfully on the time allowed for transit and with reasonable certainty, it is essential that the prescribed speed be such as can be maintained with regularity. The capacity of the engine should be such as to enable it to make the average speed, approximately, on the maximum grades. A train length limit must be used to prevent the greater wheel-flange friction from interfering with maintaining the necessary speed. Careful and close inspections must be made to prevent other than the class of commodities authorized going in fast-freight trains. Cars traveling as fast freight must be readily distinguished by a distinctive card or mark on the side of car and on the card-bill. Authorized fast-freight cars must be kept out of trains of ordinary freight. Proper understanding and arrangement must be had with connecting lines for prompt and complete delivery of fast freight from or to such lines. Full information must be given as to necessary icing or ventilating when needed. Notice of time live stock is to be loaded, fed and watered must be furnished and shown. Proper division service must be arranged for gathering and distributing fast-freight cars, to avoid stops of regular fast-freight trains and the necessary preference through terminals and in switching and changing of engines and cabooses. Full reports and records of cars set out short of destination for any reason must be made, followed by prompt action to have them moved again. A full schedule for loading and moving fast freight from points between terminals must be planned and placed in the hands of all interested in the handling.

It is advisable to arrange for the smallest number of reg-

ular trains to be run, and add sections as required in preference to annulling schedules not wanted.

It is customary on some lines to designate fast-freight trains as "symbol trains." This is known as the symbol method. A combination of letters and numbers is used to indicate, in a general manner, the origin and destination of the train. The object is to preserve its identity among other trains. Where a schedule number is used over the entire line, the use of such numbers seems to answer all purposes and a number of large railroad companies follow this plan. Where the symbol method is used, the first letter of the symbol indicates the starting point where most of the freight is taken on. The second letter indicates the destination or the point where the train ends its run. Odd numbers in the symbol indicate west or northbound and even numbers east or southbound trains. On the Pennsylvania, as an illustration, assuming J to stand for Jersey City and P for Pittsburg, J P 1 would indicate a westbound train originating at Jersey City and destined for Pittsburg. P J 2 would indicate an eastbound train originating at Pittsburg and destined for Jersey City.

First-class locomotives, adapted to high speed and in good condition, with picked crews, should be assigned to fast-freight runs, when practicable. The symbol or working book should be placed in the hands of dispatchers, yardmasters, agents, conductors and others interested, and should give information in detail as to starting time of train, time at intermediate points, how cars are to be got into trains along the line and how cars for various points are disposed of; movements to and from branch and connecting lines and arrangements for advance notice to divisions ahead.

The tonnage of the fast-freight trains should be closely watched to avoid overloading and consequent inability to make the necessary time. Schedules should be worked out to arrange for picking up high-class freight along the division and for delivering freight at the intermediate points, with quickest possible dispatch and without requiring stops by the through fast-freight trains.

It is good practice to use a card-bill of a distinctive color

for cars to be moved on fast-freight trains. Some roads use a red card; others have a red stripe across the face of the card while others again use an ordinary card with a large red or black cross on its face. This quickly attracts the attention of the yardmaster, conductor or agent, and there is less likelihood of the car going astray or becoming indefinitely side-tracked in some "pocket."

Of the many systems in use for handling fast freight and keeping a check on its movements more err in the direction of excessive complication and thoroughness than otherwise. In doing this the mistake is frequently made of placing complicated report blanks in the hands of yard and road conductors, on which a large part of their time must necessarily be spent to the neglect of other and often more important duties. There are, nevertheless, systems in use which are carefully worked out, with a view to requiring the clerical work to be done largely by men who are employed for their ability and efficiency in that particular direction.

A so-called "Red-Card" system was put in service by the Canadian Pacific Railway recently which gives prompt record of fast freight cars with a minimum of telegraphing. On cars containing freight which it is desired to give preferred movement, red cards 4¼ in. by 6½ in. printed as in Fig. 39, and properly filled out are tacked to each side.

Certain of the most important stations and junctions points on the company's lines are designated as "Red Card" stations, and to each one, a symbol letter, or letters, is assigned together with a series of numbers beginning with 1 and running up to from 50 to 1,000, depending upon the average number of loaded cars originating and forwarded from each point. These numbers and the station's symbol letter are used in numbering the envelopes in which the way-bills for cars loaded with "Red Card" freight are enclosed and forwarded. When the end of the series has been reached the envelopes are numbered beginning with 1 again and so on indefinitely. The envelope containing the way-bill for each car is made of red paper and measures 13 in. x 5¾ in. The front is printed as in Fig. 40 and the back as in Fig. 41. On the front of the envelope at

the top are blanks for filling in an identification of the car and contents and instructions for routing to destination. Below these are blank spaces for inserting the number and symbol of the forwarding station and the train in which the car is to travel. On the back there is printed a key to the symbols used for indicating the date of the departure of the car and also

CANADIAN PACIFIC RAILWAY

THIS CAR CONTAINS

RED CARD FREIGHT

AND MUST NOT BE DELAYED

Carding Station ____________________

Initial ____________________

Number ____________________

Date Carded ____________________

Kind Contents ____________________

Destination ____________________

This card must be removed immediately car is unloaded at destination.

WRITE PLAINLY IN BLUE PENCIL;

FIG. 39 — Red Card.

blank spaces for entering a record of the car's movements. When all of the cars containing "Red Card" freight which are to go forward from any station in a particular train, are ready, the agent gives the lowest symbol number to the red envelope covering the car for nearest destination, and envelopes covering cars for succeeding points beyond are given successive symbol numbers in their proper order, the car going

CANADIAN PACIFIC RAILWAY COMPANY

RED CARD FREIGHT

INITIALS.................................... CAR NO.................
(INITIALS)

TRANSFERRED TO....................CAR NO.....................

AT..............................DATE..............................190......

FROM...

TO ....

FINAL DESTINATION ....

ROUTING.. R. R.

CONTENTS...

CONSIGNEE...

FREIGHT OUT OF SS...
(SHOW HERE NAME OF BOAT FREIGHT TAKEN FROM)

CONSIGNOR.......................... WEIGH AT.........................

STOP CAR AT..............................FOR................................

TRAIN NO................SYMBOL LETTER ....

FORWARDING STATION SYMBOL LETTERS.............
" " " NUMBER..............

WEIGHT					REFERENCE TO REGULAR WAY-BILL
WEIGHED AT........................					DATE..........190... NO.......
GROSS.					STATION FROM..................
TARE..					
NET....					

INSTRUCTIONS

IMPORTANT READ CAREFULLY

This envelope will be used exclusively for cars containing Red Card Freight.

When cars loaded with Red Card Freight are accompanied by the regular Way Bills, all of the Way Bills for the car must be enclosed in one of these envelopes.

Each of these envelopes must bear the Symbol Letter of the train, in which it was first handled. Each envelope must also bear the proper car symbol and number from forwarding station.

THE FREIGHT COVERED BY THIS RED CARD ENVELOPE MUST NOT BE DELAYED. IF CAR IS SET OUT ON ACCOUNT OF BAD ORDER OR OTHER UNAVOIDABLE CAUSE, CONDUCTOR OR YARDMASTER MUST SECURELY AFFIX HERETO A "SET OUT CAR" REPORT FROM C. S. 3; AND EVERY CARE MUST BE TAKEN BY ALL CONCERNED TO AVOID FURTHER DETENTION.

ALL MOVEMENTS MUST BE SHOWN BY CONDUCTOR ON BACK OF THIS ENVELOPE.

AGENT WILL ENTER ON BLANK LINE BELOW, ANY SPECIAL INSTRUCTIONS FOLLOWING CAR

Fig. 40 — Front of Waybill Envelope.

ALL TRAINS HANDLING RED CARD FREIGHT FROM RED CARD STATIONS, WILL BE GIVEN A SYMBOL. ACCORDING TO DATE OF DEPARTURE AS PER KEY GIVEN BELOW.

KEY																															
SYMBOL	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	Y	Z	AB	DB	HB	IB	IC	OC
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

RECORD OF MOVEMENT

No. OF TRAIN	TRAIN SYMBOL	STATION NO.		DATE		CONDUCTOR
		TAKEN FROM	LEFT AT			

CONDUCTORS MUST ENTER IN SPACE PROVIDED, NUMBER OF TRAIN AND TRAIN SYMBOL, STATION TAKEN FROM AND LEFT AT, DATE AND SIGNATURE.

INSTRUCTIONS

IF TRACK SCALE WEIGHT IS OBTAINED IN TRANSIT AND IS SHOWN HEREON, AGENT AT DESTINATION, OR AT JUNCTION, IF WAY-BILL IS MADE TO A POINT BEYOND, MUST TRANSFER THE WEIGHT TO REGULAR WAY-BILL.

AGENTS MUST POSITIVELY SEE THAT ALL CARS OF RED CARD FREIGHT ARE PROPERLY CARDED, AND THAT WAY-BILLS ARE COVERED BY RED CARD ENVELOPE.

FIG. 41 — Back of Waybill Envelope.

the greatest distance having the highest number. When a train of cars loaded with "Red Card" freight is made up and is ready to be sent out the agent or yardmaster turns over to the conductor of the train all of the envelopes containing the way-bills of the cars to be sent, but before doing so he is required to make out the consist report shown in Fig. 42, the entries being taken from the envelopes. This report is telegraphed to the Superintendent of Car Service within an hour after the train leaves the station. Each item and column heading, as will be seen, has a letter symbol for convenience in telegraphing

CANADIAN PACIFIC RAILWAY COMPANY.

CONSIST "R. A." REPORT.	SENDING OPERATOR	RECEIVING OPERATOR	TIME FILED	TIME SENT
	______	______	______ M.	______ M.
	A.		B.	

FROM STATION ______________ DATE ______________ 190__

TO CAR SERVICE OFFICE, ______________

Following Cars Red Card Freight Left this Station on

Train No. "D" ________ Train Symbol "F" ________ Engine No. "G" ________ Departed at "H" ________ M.

SYMBOL LETTER AND NUMBER	CAR Initials.	CAR No.	CONTENTS	Received from Connections or Received for Red Carding DATE	Received from Connections or Received for Red Carding TIME	SHIPPING POINT	DESTINATION.	REMARKS
J.	K.	M.	N.	Q.	R.	S.	U.	V.

This Consist Report is to be made up from information shown on face of Red Envelope before each train handling Red Card Freight leaves the Station; and is to show only such cars as are handled as Red Card Freight.

Agents at Red Carding stations, other than junction points with foreign lines will show in columns Q. and R. the date and time cars are received by them for Red Carding.

Operators must telegraph this Report within one hour after train leaves Station.

FIG. 42 — Consist Report.

the reports. The Superintendent of Car Service is thus informed immediately of the departure of all "Red Card" cars, their contents, initial and number and destination. The "set out car" report (Fig. 43) is printed on pink paper and is mucilaged on the back at the top. Whenever a car containing "Red Card" freight is set out of its proper train for any reason, one of these forms is made out by the conductor or yardmaster, and pasted on the envelope, accompanying that car. The report, with the envelope, is left with the agent at the station where the car was set out, and the information con-

tained thereon is telegraphed at once to the car service office. In case a car is set out at a siding where there is no agent the report and envelope are left with the agent at the next telegraph station beyond, and the agent there forwards the report and

CANADIAN PACIFIC RAILWAY COMPANY

SET OUT CAR

"R.C." REPORT

CAR SERVICE OFFICE "A" ________ FROM "B" ________

SUPERINTENDENT "AA" ________ DATE "C" ________ 19

(GIVE HERE SYMBOL LETTER AND NUMBER SHOWN ON RED ENVELOPE)

CAR BEARING SYMBOL "D" ________

SET OUT AT "F" ________

BY TRAIN No. "G" ________ TRAIN SYMBOL "H" ________

TIME SET OUT "J" ________ ON ACCOUNT OF "K"

________ POSITION

INSTRUCTIONS—Read Carefully

IF FOR ANY CAUSE A CAR LOADED WITH RED CARD FREIGHT IS SET OUT, ONE OF THESE "SET OUT CAR" FORMS MUST BE PROPERLY FILLED OUT BY THE CONDUCTOR WHEN CAR IS SET OUT BETWEEN TERMINALS AND ATTACHED SECURELY TO THE FACE OF THE ENVELOPE CONTAINING THE WAY-BILLS FOR THIS CAR. THIS FORM MUST REMAIN WITH PROPER ENVELOPE UNTIL IT REACHES DESTINATION.

CONDUCTORS MUST LEAVE THESE "SET OUT CAR' FORMS WITH TELEGRAPH OPERATOR, WHO WILL TELEGRAPH THEM TO THE CAR SERVICE OFFICE AS DIRECTED, AND DISTRICT SUPERINTENDENT, AND THEN TURN THIS FORM ATTACHED TO ENVELOPE OVER TO PROPER PARTY.

THIS CAR MUST NOT AGAIN BE DELAYED EXCEPT ACCOUNT BAD ORDER. YARDMASTERS AND CONDUCTORS MUST SEE THAT THIS RULE IS ABSOLUTELY ENFORCED.

THE SYMBOL IS SHEWN ON FACE OF RED ENVELOPE.

YARDMASTERS WHO TAKE CARS OF RED CARD FREIGHT OUT OF TRAIN FOR ANY CAUSE, AND HOLD THEM FOR ANOTHER TRAIN, MUST ATTACH ONE OF THESE "SET OUT CAR" REPORTS PROPERLY FILLED OUT TO THE ENVELOPE FOR EACH CAR SO DELAYED AND MAKE PROPER REPORT OF IT TO CAR SERVICE OFFICE AS DIRECTED, ON FORM C. S. 4.

OPERATORS WILL USE SYMBOL LETTERS SHEWN HEREON IN TRANSMITTING REPORT

FIG. 43 — Set Out Car Report.

attends to the disposition of the car. If it is necessary to transfer the contents of a "Red Card" car to another car, the required information is entered on the envelope and red cards attached to the sides of the car to which the load was transferred. No change is made in the symbol letter and numbers

which identify the shipment through to destination. The form shown in Fig. 44 is known as the "passing report" and is used to report the arrival and departure of all "Red Card" freight from certain specified stations and junction points along the line. These reports advise the car service office of the movement of all such freight between points of loading and

CANADIAN PACIFIC RAILWAY COMPANY

PASSING "R. B." REPORT

SENDING OPERATOR	RECEIVING OPERATOR	TIME FILED	TIME SENT
		M	M

TO CAR SERVICE OFFICE FROM "B" ____________
"A" ____________ DATE "C" ____________ 190

RED CARD FREIGHT CARRYING FOLLOWING SYMBOL LETTERS AND NUMBERS PASSED THIS STATION AS SHEWN BELOW

SYMBOL LETTERS AND NUMBERS		MOVEMENT					
LOWEST No.	HIGHEST No.	ARRIVED			LEFT		
		TRAIN		TIME	TRAIN		TIME
		No	SYMBOL		No	SYMBOL	
D	F	G	H	J	K	M	N

CAUSE OF DELAY "M" ____________

____________ AGENT OR YARDMASTER

INSTRUCTIONS

THIS REPORT MUST BE MADE BY AGENTS OR YARDMASTERS AT DESIGNATED STATIONS, AND TELEGRAPHED TO CAR SERVICE OFFICES, AS DIRECTED, IMMEDIATELY AFTER CARS HAVE DEPARTED. IN MAKING UP THIS REPORT USE THE HIGHEST AND LOWEST SYMBOL NUMBERS WITH LETTERS SHEWN ON RED CARD ENVELOPE. MAKE SEPARATE ENTRIES WHEN BREAKS OCCUR IN CONSECUTIVE NUMBERS.

FIG. 44 — Passing Report.

destination. When a car or cars arrive at their destination the agent makes out a report of arrival at destination, Fig. 45, which gives the time of arrival and identification of each car. If a car is assigned to a point on a foreign road, the agent at the connecting point makes out one of these reports, but if the car leaves the main line at a junction with one of the company's

branch lines, the agent reports its arrival and departure on the branch line train on the passing report Fig. 44.

While there are numerous methods for checking the movement of fast freight, many simple and others more complicated, the one described in detail above is fairly representative of the more complicated ones. On shorter lines, and particularly

CANADIAN PACIFIC RAILWAY COMPANY

REPORT OF ARRIVAL-DESTINATION

"R. G." REPORT

SENDING OPERATOR	RECEIVING OPERATOR	TIME FILED	TIME SENT
		M.	M

TO CAR SERVICE OFFICE FROM "B" ______

"A" ______ DATE "C" ______ 19

FREIGHT WITH WAY BILLS CARRYING FOLLOWING SYMBOL LETTERS AND NUMBERS, ARRIVED THIS STATION AT TIME AND DATE GIVEN BELOW

SYMBOL LETTERS AND NUMBERS		ARRIVAL THIS STATION			
LOWEST No.	HIGHEST No.	TRAIN No.	TRAIN SYMBOL	TIME	DATE
"D"	"F"	"C"	"J"	"K"	"M"

______ AGENT OR YARDMASTER

INSTRUCTIONS

AGENT OR YARDMASTER AT DESTINATION OF CARS WILL MAKE OUT THIS REPORT IMMEDIATELY ON ARRIVAL OF CARS OF RED CARD FREIGHT TRAVELLING UNDER SYMBOL LETTERS AND NUMBERS AND TELEGRAPH IT TO CAR SERVICE OFFICE AS DIRECTED. AGENTS AT JUNCTION POINTS WHERE CARS LEAVE THE COMPANY'S RAILS, WILL MAKE OUT THIS REPORT, SHEWING ARRIVAL OF ALL SUCH CARS AT THEIR STATIONS.

IN MAKING UP THIS REPORT USE THE HIGHEST AND LOWEST SYMBOL NUMBER WITH LETTERS SHEWN ON THE RED CARD FREIGHT ENVELOPE.

MAKE SEPARATE ENTRIES WHEN BREAK OCCURS IN CONSECUTIVE NUMBERS

TRAIN SYMBOL FOR TRAIN ON WHICH CAR ARRIVES IS SHEWN BY CONDUCTOR ON THE BACK OF THE RED ENVELOPE.

FIG. 45 — Arrival at Destination Report.

those with heavy traffic, and frequent train service, a system of red envelopes enclosing card-tickets for fast-freight cars and an arrangement for identification with a system of mail reports to the car service office, should prove satisfactory. The success of such a system depends largely on good organization.

Yardmasters should know in advance, of what an ap-

proaching fast-freight train consists, and the number of cars to be taken out of the train, to enable prompt handling and to have cars to fill out, in readiness.

Fast freights are made up in proper order and all cars added should be in their proper positions, to avoid delay along the line in switching. Air-brake cars only should be loaded for these trains and cars should be carefully inspected and in good condition before starting.

CHAPTER XIX

Freight Houses

Aside from the terminal proper, there is no better opportunity for saving time than at the loading, unloading and transferring points. Freight houses and dray yards should be so designed as not only to enable quick movement between them and the classification yards, but to permit of prompt shifting and placing. The arrangement must provide for shifting with a minimum of interference with freight handlers and truck men.

Dray yards, or team tracks, are usually in or close to the business centers of cities and have usually to be laid out to conform to the size and shape of the property available which is rarely adapted to an ideal layout. While tracks holding 10 to 15 cars each, and a greater number of them, are preferable to fewer and longer tracks, these property restrictions will often compel longer or shorter tracks to be used. The shorter tracks tend to quick handling and placing of cars with the least interference with draymen. The 12 to 15 car-length tracks may be considered the maximum economical length. To save space they may be laid in pairs, similar to repair tracks, and as a matter of safety in working around teams and draymen they should be single-end connected. This gives more available track space than where ladders are put in at each end of the yard. An angle of 60 deg., between the team tracks and the ladder is permissible to get the necessary width for roadway as quickly as possible after leaving the ladder. Close spacing between each pair of tracks, 11 ft. 6 ins. or 12 ft. between centers, is advisable and for the roadway between each pair of tracks a space of as much as 40 ft. is advantageous. This gives a full width of roadway for teams, when both tracks are filled with cars, and as the width of the ordinary wagon does not exceed 6 ft. this is ample and enables teams to stand backed up to cars on each track with wagon poles turned at right angles to the body of wagon. With the increasing use

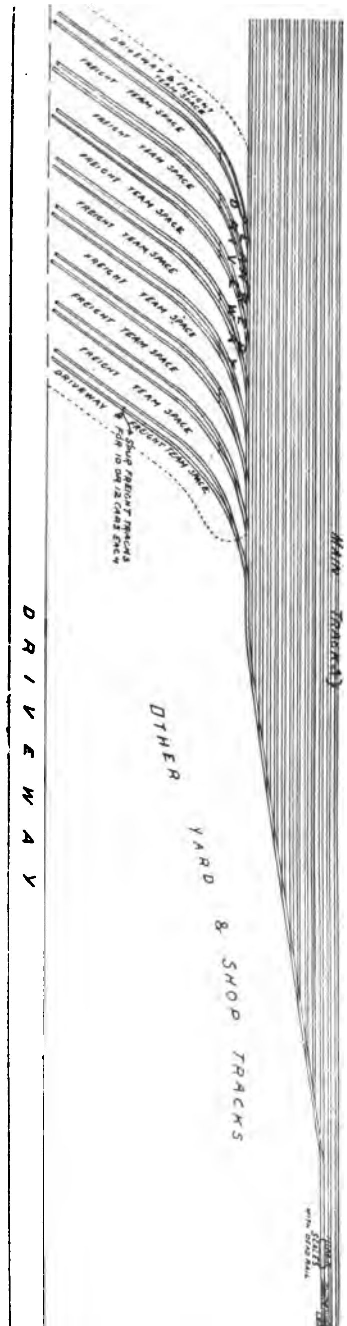


FIG. 46 — Plan of Team Yard Suggested by Mr. F. H. McGuigan.

of motors for trucking in the larger cities it is found that less roadway is needed than with teams, although the motor trucks are built considerably larger than the drays.

The roadway should be well paved and ample drainage provided to permit and encourage unloading during wet and stormy weather. It is advisable to plank or pave the tracks, or the ladder, if the yard is so located as to make it necessary to drive across them. In the sketch of a yard by Mr. F. H. McGuigan presented to the Railway Engineering and Maintenance of Way Association, a car may be put on or taken from any point or any track without disturbing any considerable number of teams loading or unloading cars on the same track, and it has the advantage of utilizing a short square piece of ground available for only two or three short parallel tracks.

There is a similar arrangement in the team yard of the Central R. R. of N. J., in its yard at Fifteenth street, New York City. The body tracks run out of the ladder, in pairs, at an angle of about 45 deg., laid to 12-ft. centers with paved driveways 35 ft. wide between the pairs.

An interesting, novel and ingenious scheme to utilize a small and valuable piece of land on 135th street, New York, for a combination team yard, freight house and platform and float bridge is that designed by Mr. Walter G. Berg for the Harlem Transfer Co.

All cars are taken in and out of floats and pass over the float bridge. The freight house is a hollow oval or ring 158 ft. x 188 ft., the building being 35 ft. wide. The court in the center is paved and used for teams which deliver their freight at doors 20 ft. apart in the inner wall of the building. The doors on the track wall are 40 ft. apart and the building gives a total frontage for 16 cars. A 4-ft. platform extends around the outer side, and the center of the circular house track is 7 ft. from the platform. This track has end curves of 90 ft. radius. Concentric with it is the main switching track, with end curves of 104 ft. radius and having a single switch connection with the house track. These tracks are laid to 14-ft. centers. Other curves of 90 and 104 ft. radius connect the outer track with the transfer bridge and storage tracks. On the curves.

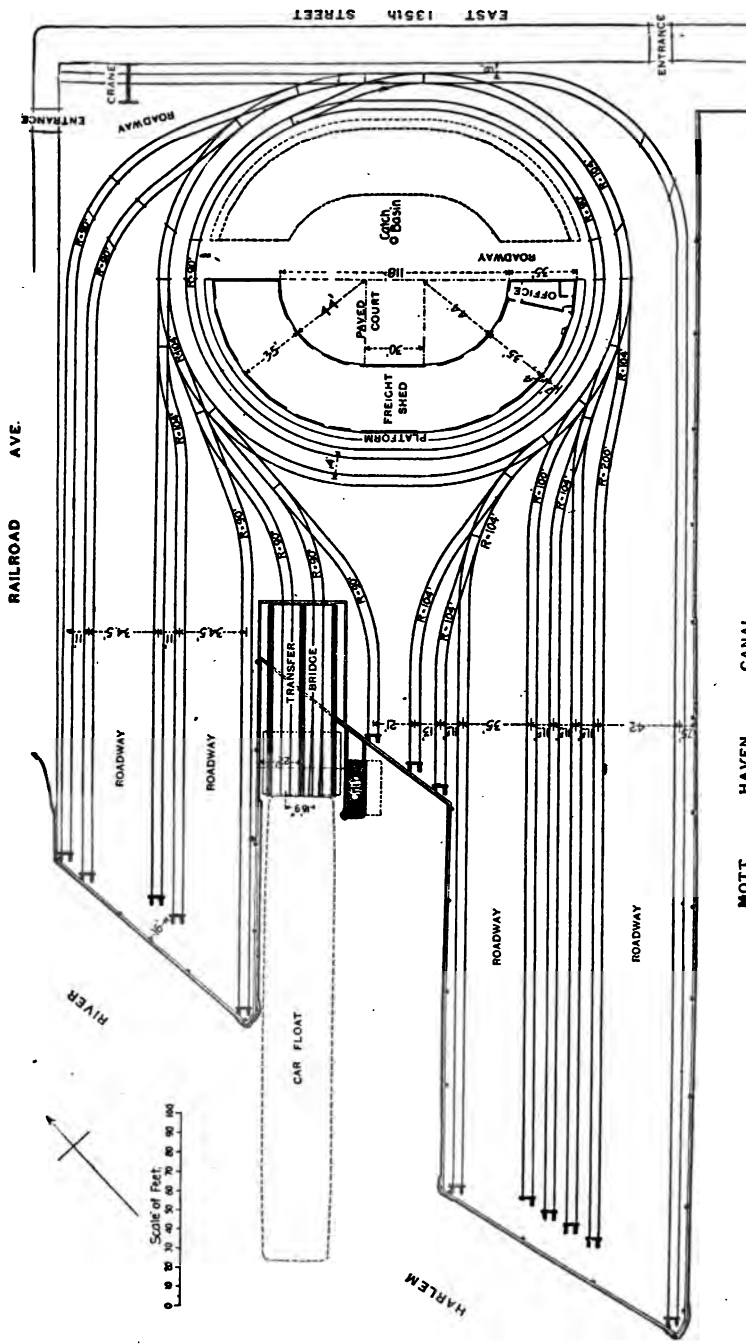


FIG. 47 — Plan of Freight House for The Harlem Transfer Co.

the outer rail is elevated 2 ins. and the gage widened to 4 ft. 9 ins. The track is laid with 70-lb. rails on pine ties for tangents and oak ties at curves and switches. The yard has a covering of cinders which serve for ballast and also for the foundation for the block paving of the roadways. Wharton split spring-switches are used with ground throw switch stands, and the bolted frogs are Nos. 3 and 3½. Because of the sharp curves a four-wheel "dummy" switch engine is used; cylinders 17 in. x 24 in., wheels 3 ft. 8 ins. in diameter, wheel base 6 ft. 6 ins., total length 27 ft., weight 45 tons. Long links are provided for coupling cars on the sharp curves and no difficulty is found in handling them. This engine hauled 11 cars, some loaded, around the curve of 104 ft. radius. The work has been satisfactorily handled.

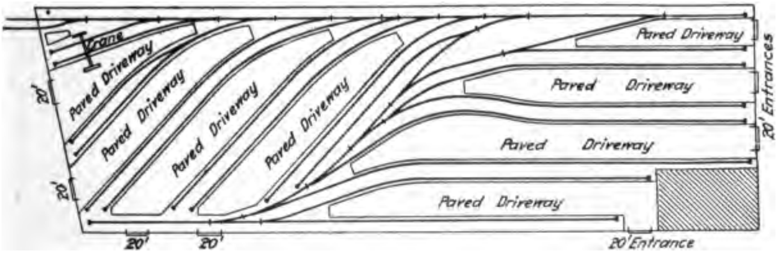


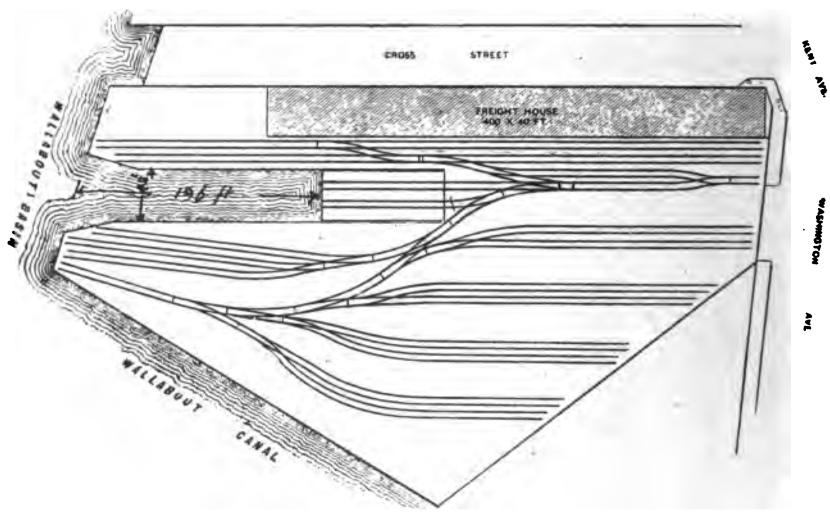
FIG. 48 — Lehigh Valley Freight Yard at West 27th Street, New York.

The scales and transfer cranes should ordinarily be located at the entrance to the yard and the crane at the point where teams with heavy pieces of freight have the best chance of getting to or from it. A good arrangement is a bridge crane, with a trolley on top, covering one track and the adjacent roadway. The crane may be operated by hand or electric power. Cranes enable prompt release of cars, and forward movement either in being loaded or unloaded. A gradual incline running from the roadway up to the floor level of a car, at the end of a track, is an advantage, and especially so where heavy machinery on wheels, agricultural harvesters, threshers, mowers, traction engines, fire engines and the like are to be handled. The same result has been attained by depressing the end of a track so the floor level of a car on the

depressed track will be on the same level as the roadway. It is easy to transfer heavy articles on wagons, traction engines, steam rollers, etc., from car to roadway or *vice versa* by this arrangement.

A good freight delivery yard getting the most out of a valuable piece of city property is that of the Lehigh Valley at West 27th street, New York, and shown in Fig. 48.

The Wallabout yard, a freight terminal in Brooklyn, is interesting principally because of the water handling, in and out, and the high value of the property. In this the tracks are



F.G. 49 — Plan of Wallabout Yard, Brooklyn, N. Y.

11 ft. centers, roadways 35 ft. between center of tracks, 40 deg. curves, Nos. 2.8, 3 and 4 frogs. The brick warehouse is two stories high and fitted with large electric elevators; loading derricks and team scales are provided.

Palmer's Greenpoint terminal in Brooklyn, N. Y., also a water-connected delivery yard, has curves of 90 ft. radius, and a drawbar 2 ft. long is used to separate cars to keep their roof corners from coming in contact.

Another water front delivery terminal in Brooklyn is that of the Brooklyn Wharf and Warehouse Co. In this there is a curve where the radius of the outside rail is 82 ft. and the in-

side rail 77 ft.; the gage was originally 4 ft. 9 ins. but is now probably 4 ft. 9¼ ins. This curve could not be satisfactorily operated until the outside rail was elevated 4 inches. There seems to be considerable diversity of opinion, however, as to whether the improvement was due to the elevation of rail or to a widening of the gage surreptitiously by the section men or through the forcing by the flanges.

The Baltimore & Ohio inbound freight house at Chicago, while not the largest freight house in the city, is in many respects one of the most convenient. It is on Polk street, close to the Chicago river, and extends parallel to the river 570 ft.

FIG. 50 — Baltimore & Ohio Inbound Freight House, Chicago.

A platform at the south end makes the total length 670 ft. For 400 ft. of its length the building is 51 ft. wide. The last 170 ft. of the west wall is carried easterly in conformity with the river bank, the width at the south end being 24 ft. 2 ins. The north end for 200 ft. is two stories high, the second story being for the offices of the freight department. The building is brick on concrete foundations. The roof of the office section is slate, that of the remainder being gravel. Between foundation walls there is a solid filling of sand to within 6 ins. of their tops, the remaining space being filled with cinders in which are bedded 4-in. x 6-in. sleepers, 3 ft. on centers. To these are nailed 2¾-in. x 8-in. hemlock boards, over which

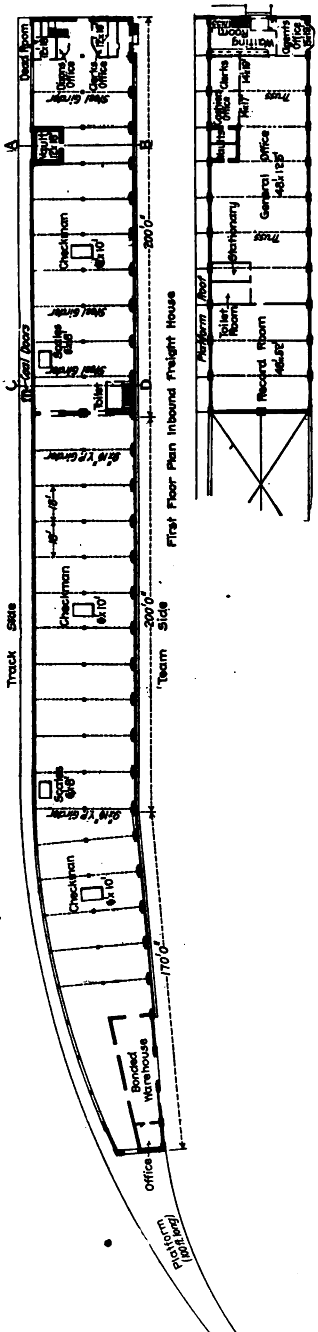


FIG. 51 — Plan of Inbound Freight House at Chicago, Baltimore & Ohio.

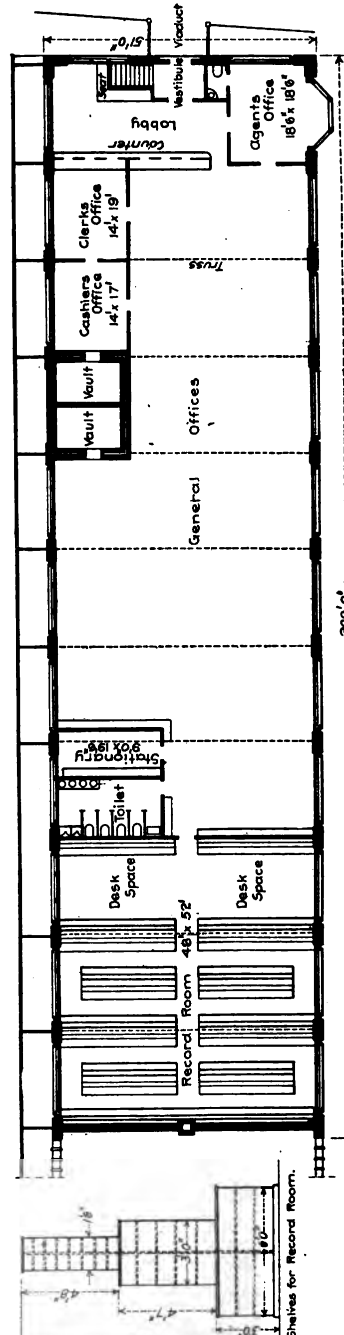
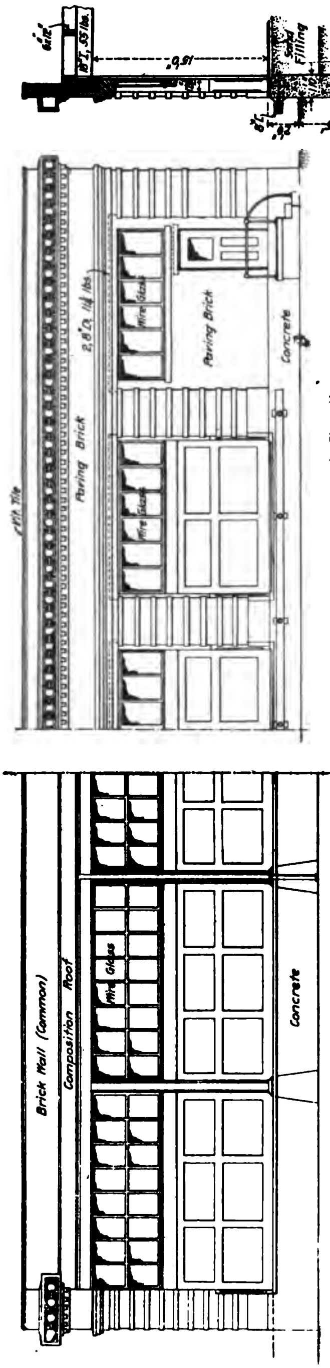


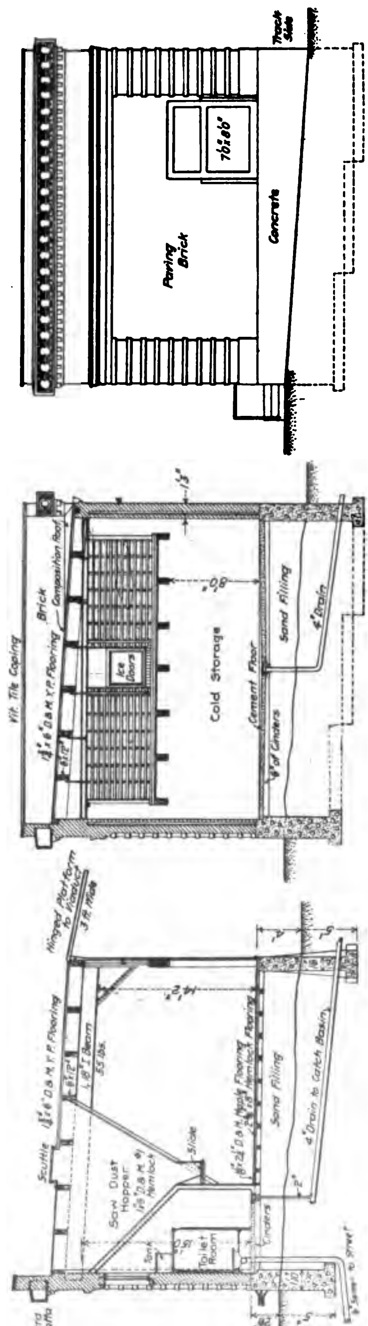
FIG. 52 — Plan of Office Floor.



Track Elevation.

Fifth Avenue Elevation.

FIG. 53 — Part Elevations and Section Through Side Walls of B. & O. Freight House.



Cross Section A-B.

Section Through Cooling Room C-D.

North End Elevation.

FIG. 54 — End Elevation and Cross-Sections of Freight House.

is laid tarred wool felt and on this 1⅛-in. dressed and matched maple flooring. The roof of the one-story section rests on 5-in. x 16-in. yellow pine girders supported on the east side of the building by the brick walls and at the middle and at the west side on I-beam columns. The west side, which is the track side of the building, has a continuous door system, the opening between columns, which are 18 ft. on centers, being closed by 17-ft. Variety horizontal folding doors. There is a 6-ft. platform on this side, protected by a roof supported by rods from the building wall. On the east, or team side there is room for two teams at each door, or 56 teams in all can load at one time. A wheel guard made of 8-in. x 12-in. white oak, faced with an 8-in. channel and supported by cast-iron brackets bolted to the concrete foundation, protects the concrete. The general freight room is divided into two parts by the south wall of the two-story part. One of the conveniences of the house is the location of the offices at the north end of the general freight room, making it unnecessary to go to the general office upstairs to transact detail business. At one of these offices, teamsters may pay their freight charges and receive their delivery tickets, while at another bills for transfer freight are handled. The dead room at the northwest corner has slat walls so that its contents can be readily seen at any time. The vault is convenient to the offices. It is 11 ft. 6 ins. x 15 ft. 6 ins. with cement floor and it extends into the second story. At the south end of the house is the bonded warehouse with office for the government officer. This office is elevated so as to allow the use of all of the floor space. The room is enclosed with brick walls and is nearly fireproof. The distribution of the freight on the floor of the general freight room is such as to leave an aisle on each side, instead of through the center. This avoids any chance of the freight piling up against the walls and hiding pieces, causing loss of time in looking for them. The general offices occupy all of the second floor except 52 ft. at the south end which is used for a record room. These offices are light and have room for double the force that will occupy them at the outset. They are entered directly from the Polk street viaduct crossing the railroad yards; and

also by stairways from the first floor. The agent's office, at the northeast corner has a bay window from which he can see at any time the condition of business along the team side of the building. A complete desk telephone system is installed for every clerk needing one. Roomy, ventilated lockers are provided for the office force. They are ranged along the walls of the toilet and stationery rooms in the southwest corner of the office. The record room has storage for five years' records. Additional space is available above the offices under the roof. Shelving built in conformity with the road's record system is placed in the room as shown in the plan. The two sets along the north wall are for current records, there being room for eight months' daily records. The compartments are each made just the size of a daily record book and are numbered for the days of the month. Any clerk wanting the records for a particular day can put his hand on the book at once. By this system as many clerks, as there are books for the month can be looking up back records for that month without delaying one another. As the "current" shelves fill up, their contents are moved over, a month at a time, to the storage shelves.

The plans for an outbound freight house near this inbound house have been completed. The distance between the two houses is about 300 ft. The outbound house will be 780 ft. long and 30 ft. wide. The walls will be of hard-burned paving brick with terra cotta cornice and window sills.

A cooling room 18 ft. 6 ins. x 27 ft. 6 ins. will occupy the extreme end of the building. Ice will be delivered to it most conveniently from the adjacent Taylor street viaduct. The sawdust is delivered to the hopper through a scuttle in the roof, a viaduct along the western side of the building enabling wagons to be brought to within a few feet of the scuttle. The floor of the house slopes from the east, or team side, toward the west 7 ft. of the width of the building, the total fall being 6 ins. It is level the remaining distance; also for the same width along the north wall.

The Roadmasters' Association of America in a committee report for 1903, prints the following:

"Where piers and warehouses are built with a dock on each side, from one to three tracks down the center of the pier, with trucking

space on the outside, and the edge of the pier, are needed. When warehouses are parallel with the wharf front, space can be economized by having tracks enter the building at the side and run at right angles therewith, or nearly so, and about half-way across the width of the building. This method of lay-out will give more car room, or rather more loading room, than when the track is parallel with the building. This is especially the case where the tracks are in pairs, say at 12 ft. centers, with trucking space of 15 to 20 ft. between one pair and the next, putting in as many sets of tracks as are needed. The ends of the tracks should be within a reasonable distance of the wharf front, to save as much as possible in the work of trucking, a very considerable item of cost in handling freight. Tracks abutting on wharves or ending in warehouses should be level or there will be danger of running cars into the water, or against the building."

Freight houses usually have a track along one side and a driveway on the other, although more tracks are sometimes worked. The author knows of instances where four tracks alongside each other, without platforms between, were handled in a fairly economical and prompt manner. The cars have to be "spotted," however, to bring the doors opposite each other.

Where the amount of freight handled is sufficiently heavy to justify it separate houses for inbound and outbound freight are recommended. When this is done the outbound house should be narrow, 25 or 30 ft. in width, to shorten the track haul from the team delivery to the car door. To increase the car capacity it will be wiser to put in more tracks alongside and these should be spaced to permit trucking platforms 6 to 8 ft. wide to be built between each two tracks. The use of these trucking platforms renders "spotting" of doors unnecessary and obviates the straight line trucking through several rows of cars by which the truckers are at all times liable to meet, causing confusion and delay. In the process of spotting cars exactly opposite the doors a large amount of expensive switching is done, while holding up the work of transferring and causing a force of men to be idle for a time. When the cars are taken out the same process, with its results is repeated as the cars must be recoupled. There is more liability of injuring freight-handlers than with the "isle" platforms. A platform used for transfer purposes solely, should be from 14 to 16 ft. wide, roofed and with a track on each side.

Scales should be provided at frequent intervals, in freight houses, 50 or 100 ft. apart, and arranged along the side where

freight delivery is made. The beams should be parallel with and against the wall, leaving no obstruction to trucking.

If a separate house is built for inbound business it should be wider so as to unload cars, release them and hold the freight for delivery. In track capacity and landing platforms for trucking between parallel tracks, the general rules for outbound houses may be followed. The inbound and outbound freight houses should be so located with reference to each other that the empty cars may be quickly moved to the outbound houses for reloading. In some instances the two houses may be adjoining, and cars emptied at the one may be reloaded at the other without movement.

Fig. 55 — Inbound Freight House of the N. Y., N. H. & H. at Worcester, Mass.

The inward freight house of the New York, New Haven & Hartford at Worcester, Mass., stands on an awkwardly shaped property which was utilized in a unique manner. There was not sufficient room to continue the second track to the end of the house alongside of the first track. The inside track was, therefore, cut off in such a manner as to extend the second track alongside a platform five car-lengths beyond. This enables five cars to be handled while the other two tracks are being switched and avoids cessation of freight-handlers' work while the house is being worked or "set" by the yard engine.

There is difference of opinion as to the advisability of putting a narrow platform on the receiving side of outward freight houses. That it is an advantage to teamsters in getting rid of their loads cannot be questioned. On the other hand, it requires close checking and usually a larger force of receiving clerks than where the freight must be unloaded directly into the house. With the continuous or overlapping-door system, the absence of a platform is not so noticeable to the teamsters.

Some roads build freight houses with one side entirely open and without posts. The doors are so arranged as to slide by each other, enabling an opening to be made wherever the car door stops. This arrangement renders the platform between the outside wall of the freight house and the first track unnecessary. Where the side of the house is close to the track there is, naturally, some difficulty in spotting cars opposite the doors. The posts may also interfere where the platform is inclosed. The Boston & Maine has wooden freight houses with side posts set 6 to 8 ft. in from the side of the building. The roof trusses overhang these posts and carry the side walls and doors. The doors are hung on two parallel tracks to be run by each other and also to be run apart to provide larger openings. At water terminals where freight sheds must accommodate vessels, teams and cars the door problem is complicated. On the water side the doors must be 16 to 20 ft. high and continuous. It is best to hang them outside of the posts though there must be a fender platform outside, not over 2 ft. wide. Doors for admitting teams to the shed must be large, 14 ft. high x 16 ft. wide. An inexpensive and fairly convenient system of doors is to make them in halves and hinged strongly at the top. The lower half, which is counterweighted slides up inside the upper half and is held by a crotch hitch to the lower corners of the upper half. The whole is then drawn up to a horizontal position. For sliding door hangers the essential features are strength, simplicity and impossibility of getting off the track.

Where the house abuts on the street at least 20 ft. of good paved roadway, without obstructing the street should be provided. Where the country is level, teams will haul heavier

loads and in building roadways, approaches, etc., this should be kept in mind. While the width of from 14 to 16 ft. has been given for transfer platforms, the class of commodity to be handled should be considered. Cotton for instance, and other heavy baled goods may be handled to better advantage over a platform from 10 to 12 ft. wide. The height of the transfer platform should be that of a car floor, when standing on a track alongside.

To transfer an occasional car of coal or grain, two tracks alongside each other, spaced 10 ft. 6 ins., and with a difference in elevation between the two of 5 ft. 6 ins., are used. The commodity to be transferred from the car placed on the high track is shoveled into chutes running into the lower car.

The Baltimore & Ohio has in service at its Twelfth street yard, Chicago, a heavy gantry crane. The main hoist has a capacity of 25 tons and the auxiliary hoist a capacity of five tons. All motors of the gantry and hoisting machinery are operated by electric current of 500 volts, which is obtained from the near-by power house of the Pennsylvania Lines West. Two conductors are carried on poles parallel to the runway and there is a short trolley supported on an extended arm on the end post. The gantry has a width of 42 ft., center to center of ground rails, and spans a wide team yard, which has a car track on each side. The ground rails are supported on pine sleepers 12 ins. square, and the length of traverse covers 12 car-lengths. This gantry commands a large area, as it is possible to unload from 24 cars without shifting them, and the cost is much less than that of a traveling crane supported on longitudinal girders. The gantry is kept in almost constant use handling heavy structural steel, machinery of all kinds, wagons and heavy bulky freight, which is usually loaded in flat or gondola cars. A short platform has been built in the teaming yard, so that outgoing freight can be handled from the dray to the platform without waiting for a car to be switched in, and in a similar manner machinery is rolled out from box cars to this platform and then handled by the crane to the drays.

Another example of modern practice in freight house de-

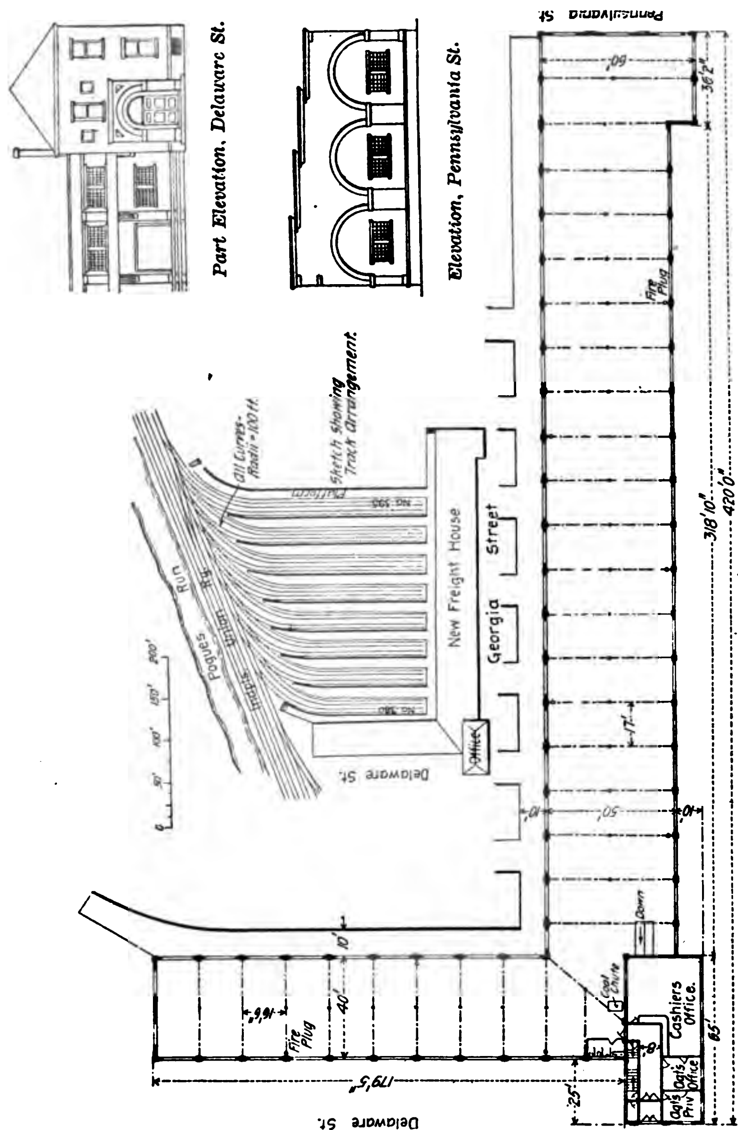


Fig 56 — Pennsylvania Freight House at Indianapolis, Indiana.

sign is the new house erected by the Pennsylvania Lines West at Indianapolis. A general plan, elevations and cross-sections, are shown in Figs. 56 and 57. The property available was L-shaped, with the main stem 50 x 355 ft. on Georgia street, and a lateral wing on Delaware street 40 x 180 ft., with a two-story and basement office building 30 x 65 ft. on the corner. Entering from the south are 16 tracks, having a total capacity of 88 cars, spaced in pairs on 11-ft. centers and between pairs on 34-ft. centers to allow for a 12-ft. platform between. At the south end all tracks are laid out on a curve of 100 ft. radius to keep them within the limits of the property owned. The foundations are of coursed rubble masonry and the walls are No. 1 common brick with the face laid all stretchers in red mortar, with half Indiana limestone trimmings. The floor, built according to the recommendations of

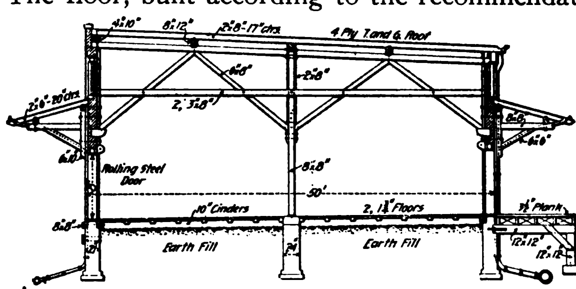


FIG. 57 — Cross-Section of Pennsylvania Freight House.

the Association of Transportation Officers of the Pennsylvania Lines, slopes towards the driveways with a 6-in. fall in the width of the building and is composed of three thicknesses of 1¾-in. oak with the top course laid at an angle of 45 deg. with the axis of the building, on fernoline-treated sleepers imbedded in cinders on an earth fill. The 4-ply gravel roof, supported by purlins and braced main rafters, requires but slight fall and gives good working height and good lighting with least cost. All door openings are fitted with rolling steel doors, with the cast-iron door-joint guards extending up to and forming a seat for the 4-beam lintels.

As land values in larger and even smaller cities continue to increase, it will probably be found economical, in many instances, for railroad companies to abandon their large city

yards, selling the land or using it for other purposes, and establishing outlying switching yards, with a few tracks leading to central freight houses. When the Great Central Ry. entered the City of London, England, it found the cost of land for its right of way and terminals almost prohibitive. A freight warehouse was built five stories high and a basement 16 ft. below the street level. The railroad is on the street level at the terminal, but there are no grade crossings. The freight warehouse is 384 x 255 ft. and is entered by six tracks in groups of three with a 20-ft. platform at the level of the car floor on each side of each group. On the opposite side of the outside platforms are the team roadways. Each set of tracks has three traversers, which are transfer tables running on transverse rails level with the track rails, the cars running up short inclines on the traverse. The cars are short, weighing 18 tons when fully loaded, and eight tons when empty. For inbound traffic the two outer tracks are for unloading cars, the empty cars being shifted by the traversers to the middle track. For the outbound traffic, the two outer tracks are for loading the cars which are then shifted to the middle track and run out into the yard. Cranes handle the freight on the platforms, and elevators are provided to carry freight up to the warehouse floor above. Across the front of the building runs a transverse track, with a turntable at the intersection of each longitudinal track. The short cars can easily be transferred, by this means, from one track to another. Two 20-ton hydraulic car elevators connect the car tracks with the basement tracks, and a driveway with a grade of 1 in 28 (3.57 per cent.) leads from the entrance yard for teams, to the basement. This incline is inside the building and has an arched entrance with rolling steel shutters. No engines are allowed in the building, the cars being moved by ropes, for which numerous hydraulic capstans are provided.

A freight terminal at Manchester, England, is built on the same system. It is approached by a four-track line, and on the main level there are ten tracks, six of which (in pairs) extend into the building between long platforms. On each side of the yard is an incline track leading to the low-level yard

or basement, which has five tracks, all connected by switches. At each end of the basement is a transverse track, intersecting the yard tracks, and connected with them and the basement tracks by turntables. A three-story warehouse building is above the freight station proper. The terminal has accommodations on the upper level for 48 small English cars inside and 257 cars in the yard. On the low level there is accommodation for 56 cars inside and 74 in the yard. There are 17 hydraulic cranes of 1½ tons capacity on the high level and 11 on the low level with three of 2½ tons capacity on the low level and two of 10 and 15 tons capacity in the yards. The roadways give room for 40 wagons on the high level and 100 on the low level, with stabling for 130 horses under the arches, carrying the inclined tracks. The stabling is provided for the reason that the English railroads collect and deliver freight with their own teams.

In Philadelphia, the Philadelphia & Reading depressed its tracks to eliminate grade crossings and built a brick freight house 33 x 308 ft. with an upper floor for the delivery of freight from teams at the street level. Six elevators with platforms 10 x 4 ft., carry the freight to the lower floor, where it is transferred to cars standing on the house track. For the transfer of heavy freight, direct from wagons to cars, there is a traveling crane, spanning the track nearest the foot of the retaining wall and extending over the side of the parallel street above.

Where the cost of land is greater than that of additional building and equipment required to install tracks on two floors, such action would seem wise. It is roughly estimated $2 per square foot, extra, above the cost of a one-story house, gives a good mill-construction, slow-burning type of building two stories high. This arrangement could be easily established on a side hill location, but could also be established in flat localities with comparatively little additional expense, and prove a profitable and economical investment. Coaling stations quite frequently have approaches of 4 to 6 per cent. or even 10 per cent. for the loaded coal cars, which are pushed up by a small dummy car on the end of a cable, or by other suit-

able means. At coaling piers, etc., the loaded cars, with 30 to 50 tons of coal, are sometimes hauled up inclines of 25 per cent. to the top of the pier by cables. Similar methods could be used for freight houses, and if the low level tracks were depressed 4 ft. or 5 ft., the incline approach to the high level would be quite short.

The group of yards and freight houses of the New York, New Haven & Hartford in Providence, R. I., are in the center of the city and practically surround the Union Station. They are within a stone's throw of the State Capitol building and the City Hall and are a good example of the utilization of awkward pieces of ground. While there are some 22 stations and small yards within the limits of Providence, the group of four yards in the center of the city take care of the bulk of the traffic. Providence is a city of 300,000 inhabitants and is the largest manufacturing center in New England.

Fig. 58 shows the bulk delivery yard, No. 17, at Gaspee street. It has a capacity of 675 cars of which number 458 can be placed accessible for teams, and the remaining 217 are "center" tracks from which cars may be loaded through other cars or on which empties or loads may be held. Driveways 43 ft. wide are placed between rails, and the tracks are laid to 12 ft. centers. In this yard ordinary city freight is handled for both inward and outward movement.

Fig. 59 shows the outward bound freight house No. 3 with transfer platform. This is located on West Exchange street, at the west end of the Union Passenger Station, south of the main tracks and opposite yard No. 17 described above. The transfer platform is 12 x 720 ft. and covered. No. 3 freight house is 680 ft. long, 20 ft. wide for a distance of 300 ft., and the remainder 50 ft. wide. It has 41 receiving doors on the street side.

Fig. 60 shows yard No. 14 at Canal street, and inward freight houses Nos. 1 and 2 located at the east end of the Union Passenger Station about 2,500 ft. east of the yard and freight house described above. The house in the foreground is No. 1, 60 x 525 ft. with 31 delivery doors. A 20-ft. platform extends alongside this freight house. There is also a covered

FIG. 58 — Gaspee Street Bulk Delivery Yard No. 17 at Providence, R. I., New York, New Haven & Hartford.

Fig. 59 — Outbound Freight House and Transfer Platform at Providence, R. I., N. Y., N. H. & H.

FIG. 60 — Canal Street Yard at Providence, R. I., New York, New Haven & Hartford.

FIG. 61 — Stillman Street Yard at Providence, R. I., New York, New Haven & Hartford.

platform 20 x 360 ft. connecting this house with No. 2 in the distance. The No. 2 freight house is 70 x 300 ft. with 15 delivery doors and an 8-ft. platform on the track side. At the extreme east end of this house there is an extension platform 25 x 221 ft.

Fig. 61 shows yard No. 15 at Stillman street on the north side of the main tracks and opposite Nos. 1 and 2 freight houses. The stub end of this yard is separated from the stub end of yard No. 17 by Francis and Gaspee streets. This is a

FIG. 62.— Interior of Storage Warehouse at Cincinnati, Baltimore & Ohio-Southwestern.

bulk delivery yard which is used preferably for meat, fruits, vegetables and other perishable freight. Its capacity is 440 cars of which number 311 can be placed accessible to teams. A large power crane will be seen on the left for unloading from cars to teams or *vice versa*. The width of driveways is 35 ft. between rails; tracks are laid to 12 ft. centers. The large building on the left is the Rhode Island State Capitol.

Mention should be made of storage warehouses in connection with freight houses. That of the Baltimore & Ohio-Southwestern at Cincinnati, Ohio, is one of the latest examples.

FIG. 63 — Street Side of Warehouse.

FIG. 64 — Track Side of Warehouse, Showing Transfer Platform.

and is probably the largest in the country. It is of brick and mill-building construction, five stories high. Figs. 62 to 64 show the street and track elevations and the interior of one of the upper floors.

The new freight terminals of the Wabash in St. Louis, occupy approximately 300,000 sq. ft. of ground close to the heart of the city and are said to provide the most extensive facilities of their kind in St. Louis. The inbound freight house has 81,000 sq. ft. of floor space, including the basement, and the outbound house 22,000 sq. ft. There is track room for about 130 cars and all of the cars on all of the tracks are available to either or both houses. In addition, there is a "fruit auction house" with about 4,400 sq. ft. and two tracks adjoining.

The inbound house is two stories high for 501 ft. of its length and one-story for the remaining 345 ft., with a three-story office portion. The outbound house is one-story high throughout, its construction being similar to the inbound house. Sections through the inbound house are shown herewith to illustrate the details of construction. Referring to the section through the office portion, the foundations are concrete and the columns in the basement are channels. The first floor is cement laid over brick arches sprung between 10-in. I-beams supported by 15-in. 80-lb. I-beams. The building walls are brick, the interior construction above the first floor is timber, and the roof is gravel. The first and second floors are crowned 2 in. Both sides of the house have steel rolling doors. The track side has a 5-ft. platform and both sides a 5-ft. canopy. The one-story portion of the house, which was added after the part just described had been completed, has no basement, the space between foundation walls being filled in. It has a wooden floor, composition roof and sliding doors. The width of this portion reduces from 42 ft. where it adjoins the higher portion, to 24 ft. at the south end, owing to the irregularity of the property.

There are six tracks between the inbound and outbound houses with island platforms 6-ft. wide between tracks except the center two. As already mentioned, there is track room here

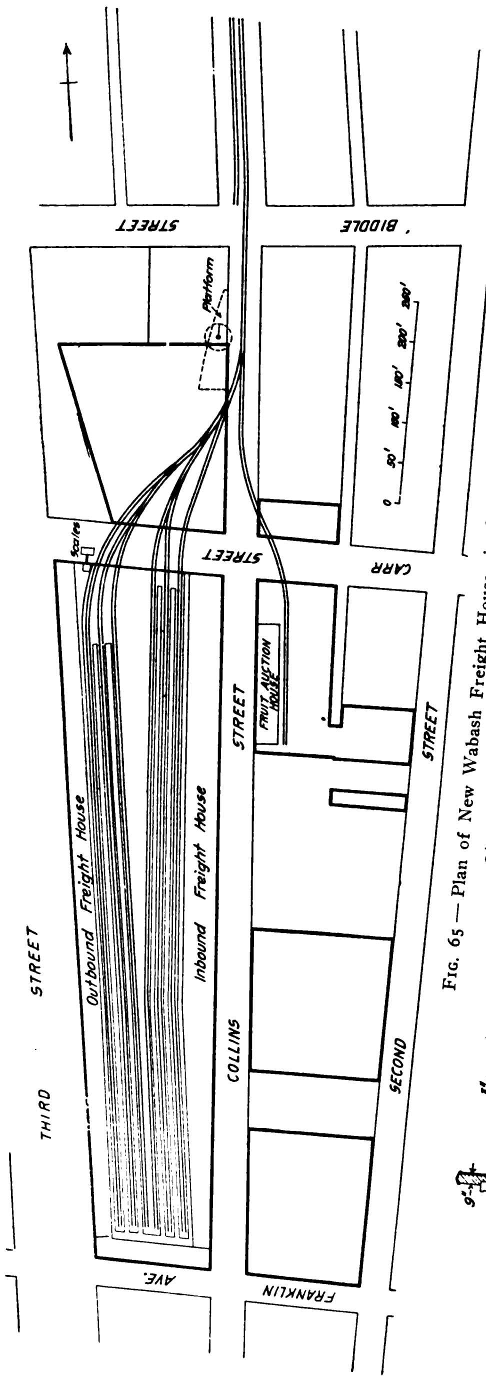


FIG. 65 — Plan of New Wabash Freight Houses in St. Louis.

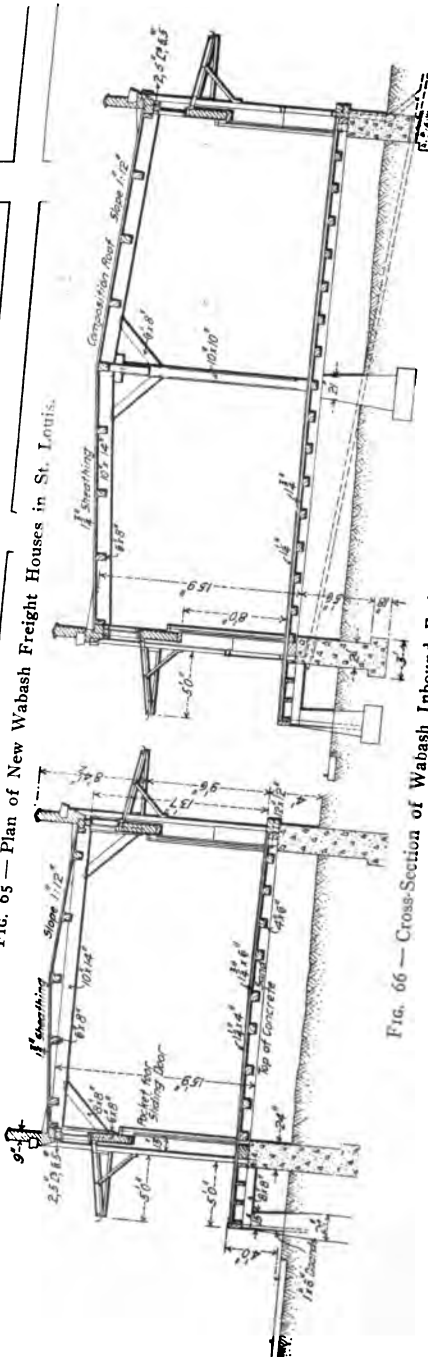


FIG. 66 — Cross-Section of Wabash Inbound Freight House at St. Louis.

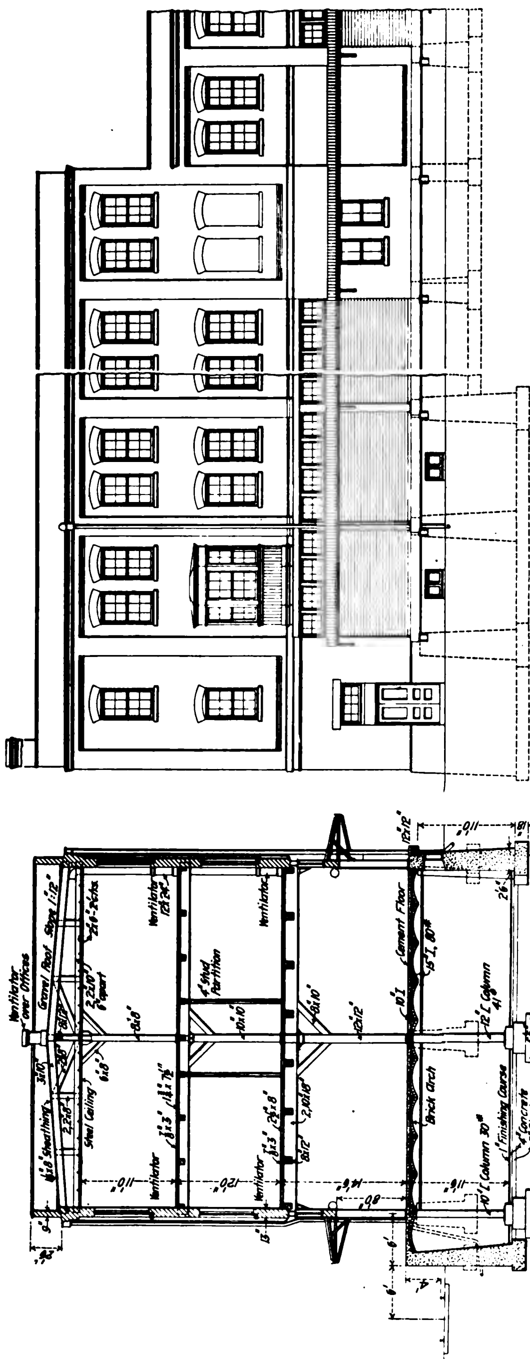


FIG. 67 — Part Side Elevation and Cross-Section Through Office Portion of Wabash Inbound Freight House at St Louis.

Grain cars are run through to the grain yard, having a capacity of 220 cars, into which they are backed and from which they are pushed to the grain dock at Pier 8. From the receiving yard the cars are run back to the switching leads, from which, by through tracks, any pier may be reached. Withdrawing the cars from the piers, loaded or unloaded, they are pulled to the throat of the outbound yard near the northeastern end, and then run into that yard which has a storage capacity of 399 cars. At the southeastern end a ladder track connects all these tracks to the outgoing track through the tunnel. The transfer bridges are reached by several through tracks leading from the receiving yard, which permit rapid and continuous transfers and reduce the danger of blockade. The caboose track, it will be seen, is conveniently located near the entrance of the yard.

Another modern type of a freight delivery, water-front pier and float-bridge arrangement, at a point where property values are high is that of the New York Central yard at 69th street, New York. This is shown in Fig. 69, and extends from 60th to 72nd streets along the North (Hudson) river. It includes an elevator, six piers, a transfer dock and an engine-house with the usual minor structures, and has a large storage capacity for freight cars.

The plan shows the freedom with which all tracks on the piers and transfer docks may be approached from the main track and how the remaining space has been ingeniously used for storage tracks.

The Bush Terminal in Brooklyn is also a tide-water front delivery yard where every available foot of space had to be utilized to its utmost because of the high values of property.

The Pinner's Point terminal of the Southern Railway near Norfolk, Va., represents a fair development of a tide-water frontage where ample space was available and where land values were moderate. A large proportion of the freight handled through this terminal is cotton.

Much available and interesting information on the subject of piers for handling freight, is contained in the report of the Committee on Yards and Terminals of the American Rail-

way Engineering and Maintenance of Way Association, March, 1903, from which the following is quoted:

"At large marine terminals, whether ocean or lake ports, the railroad facilities for handling business differ very materially from those of inland terminals. At such terminals it is advantageous to unload into warehouses all classes of freight which can be placed on platforms, and only retain in the cars such classes of property as can- [illegible] accommodations. The great bulk of

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classifications, which are usually as follows: C[illegible] the export
piers, storage piers, in and outbound freight sta[illegible]m tracks,

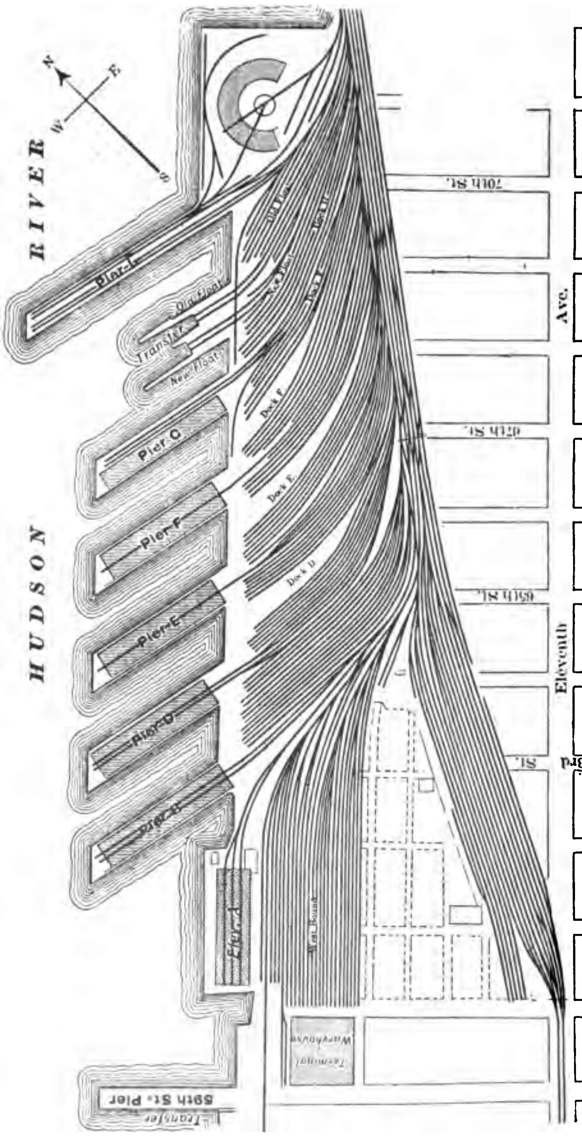


FIG. 69 — Plan of New York Central Yards and Piers at 69th Street, New York City.

elevators, stock pens, etc., or to the yard from which the car floats are moved for making deliveries to other railroads in the harbor. This yard should be so arranged that the cars, after they are separated or classified as above, can be readily moved to the proper point (either the coal pier or the freight pier) without interfering with the other movements. The yard is not often so well developed as receiving yards at inland terminals because of the high value of terminal property at such points. As a rule the area or track room at a terminal does not increase in proportion to the growth of the other facilities. It should have a receiving yard, in which the trains on arrival are held previous to being classified. It should have a departure yard, in which the trains ready for movement are held. There should be caboose tracks so arranged that the caboose from an inbound train

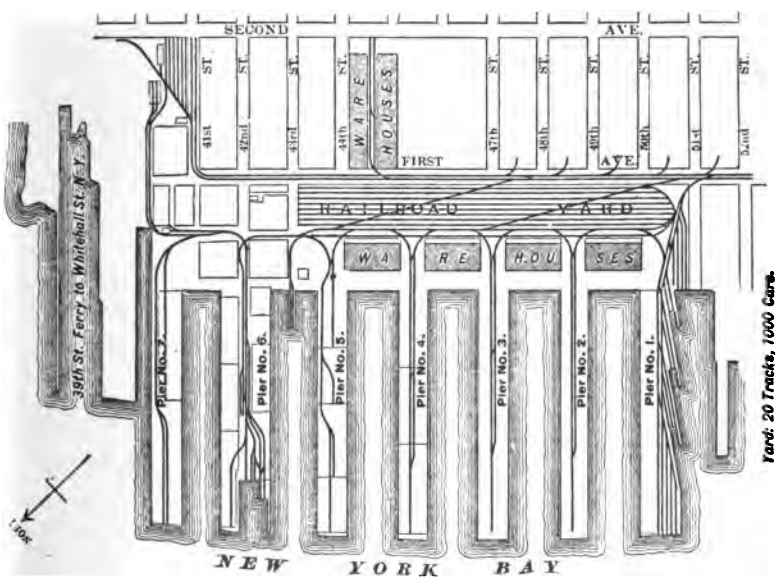


FIG. 70 — Plan of Bush Terminal, Brooklyn, N. Y.

can be readily placed upon the rear of an outbound train. The movement of engines from the engine-house to the receiving or outbound tracks should be arranged to give a minimum amount of interference.

Covered Lighterage Piers

"These should be about 600 ft. long and about 125 ft. wide, with two tracks in the center, built at such an elevation that the floors of the cars will be level with the deck or floor of the pier. It is sometimes recommended that the sides of the pier should be composed of iron rolling or folding doors, but this feature does not seem to be desirable. It cuts down the storage space and very frequently it will be found that the post between two doors will obstruct one gangway to a lighter. Most lighters have but two gangways, and where a railroad company handles the bulk of its lighterage business, the lighters

are usually built with a standard spacing for the gangways, so that the doors of the pier can be spaced to accommodate the gangways. There should be a platform 4 ft. wide, outside the walls, on the three water sides of the shed, the platform being provided with mooring piles or posts for securing vessels. Many of the older piers were built with sides having an inward slope or batter of about one inch to the foot, or usually about 3 ft. in the height. This was done so that in loading or unloading lighters the packages would not strike the sides of the building. This contingency is better provided against, however, by having a wider platform outside of the building, and in fact, practically all modern pier sheds are built with vertical sides.

"The shed or superstructure of the pier should be of steel frame construction or slow-burning mill timber construction. If wood is used it should be whitewashed, to prevent sparks from setting fire to

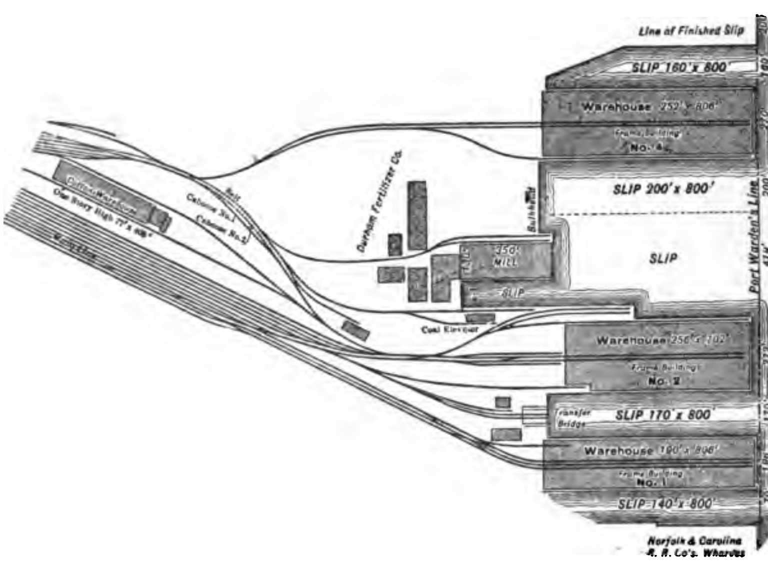


FIG. 71 — Southern Railway Terminal at Pinner's Point, Va.

it. In large cities the law usually requires steel construction. The roof should be designed to give as much light as possible during the day. This is preferably effected by means of windows on the sides of a monitor roof, and these may be supplemented by raised skylights or small monitors running transversely across the side slopes of the roof, parallel with (and between) the roof and trusses. Flat skylights are objectionable, as being liable to leak and to be damaged by storms or heavy snow. The monitor roof should have pivoted sashes to provide for ventilation, the sashes being handled by suitable mechanism. The shed should be lighted by electricity at night. It is important to provide good, smooth floors, and the lamp room should be thoroughly fireproof. The height of the floor above mean tide will vary with the kind of vessels to be handled and with the daily tide changes. These must all be carefully studied in order to arrive at the proper

height above mean tide at any given location. Usually such height as will make the deck of the pier and boat at the same elevation at mean tide will be the most satisfactory. Between piers there should be a water space of about 200 ft. The tracks running into the piers should be so arranged that they will feed directly to and from the proper part of the general yard without interference. This type of pier will be often used for export business, and will then take on the features of an export pier and be built accordingly. In weighing freight, automatic scales are being used, and should result in a reduction of expense.

"Where heavy tides must be provided for, adjustable ramps or inclines should be introduced in the floor, the outer edge of the ramps being in line with the edge of the pier. By this means freight may be trucked to and from lighters at any stage of the tide without serious interference. The ramps are usually 15 to 20 ft. long, fitted with counter-weights and worked by a worm gear. Fixed ramps are sometimes used for convenient access to the lower decks of vessels.

Open Lighterage Piers

"These should be about 35 ft. wide and 600 ft. long, with a 6-ft. platform along each side. In many cases only two tracks are used, but long piers or piers which have more than two berths along each side should, however, have a third track, connected with the others by crossovers. This facilitates the shifting of cars and enables the berths at the outer end of the pier to be served without disturbing the work that is being done at the other berths. A pier with three tracks should be 45 to 50 ft. wide, and with tracks at least 11 ft. 6 in., center to center. The floor of the pier may be depressed so as to bring the car floors level with the 6-ft. platforms on each side. This, however, is not usually done.

"For most freight that is handled by derricks, the boom derricks on the lighters are used, but the pier should have a power crane or derrick of greater capacity for handling freight that is too heavy for the lighter derricks. This crane may either be stationary (in which case the lighter must be moved to the crane) or it may travel by power along the platform to any desired point. Traveling cranes of this type are extensively used at water terminals in Europe. Heavy freight, however, is usually handled by special lighters with powerful derricks, as the freight may have to be discharged at places where pier derricks are not provided. Stationary cranes for handling heavy loads, cases of glass, machinery, etc., are also of advantage. There is undoubtedly much room for the improvement of freight-handling facilities at piers, largely by the introduction of machinery for the purpose of effecting greater rapidity and economy than are possible under the common method of employing men with trucks or slow hand-winches and derricks. At European water terminals, traveling power cranes are extensively used along the sides of piers and docks.

"The piers should be built at such a height above water that cars to be unloaded can be most conveniently handled. A study of the tides and the freeboard of boats is necessary to arrive at this height. Owing to storms and specially high tides it is necessary to build the piers at a height above mean tide slightly greater than that at which work can be done to the best advantage. There should be an open water space of at least 150 ft. between the sides of these piers. This space should prevent boats from being blocked in, and would give

space for a tug with a lighter alongside to pass through two lines of boats and bring a barge from the bulkhead or land-end of the pier to the stream (or *vice versa*), without interfering with the loading of boats alongside the piers. Ample space will be found advantageous when the ice is running free.

"The piers should be so located that cars will feed directly to and from the proper part of the cluster or general yard with the minimum amount of interference. The pier is principally used for the handling of coarser products moving in gondola or flat cars. It is frequently built wider than described where stone, pig iron or other freight requiring storage on the dock is to be handled. These conditions, however, will vary with the conditions of each road. The pier above described is the type best adapted for the handling of such business as will not have to be unloaded and held or stored on the pier.

Export and Storage Piers

"These should be constructed for ample storage, as well as for the economical working or handling of export freight. Under the traffic rules export freight must be held free of storage for 60 days. This is done to provide time for the arrival of steamers, or to make arrangements for the shipments. An export pier should be about 600 ft. long and about 125 ft. wide. On account of the great height of ocean steamers, it should usually be double-decked, the first-story deck having 20 ft. head room; second story, 18 ft.; height at eaves about 43 ft. The pier should be surrounded with a 6-ft. platform, arranged with the proper number of mooring piles for tying up vessels. The pier should be provided with a proper number of fire hydrants and a general system of fire protection, included in which a chemical engine is desirable. There should be two tracks running down the center of the pier, arranged at such an elevation that the floor of cars will be level with the deck of the pier. The house should be furnished with roof lights and electric lights, as already noted for lighterage piers. In fact, the general features and requirements for storage piers are similar to those of covered lighterage piers, already described.

"If possible, at least one track should be provided on the upper floor. In any case there should be a proper number of elevators for moving freight from floor to floor, and more elevators will be required if the second story is not provided with a track. In case flour is to be handled, and there is no track to the second floor, it will be found desirable to supplement the elevators by an endless barrel conveyor, such as is used in flour warehouses. The use of this type of conveyor is recommended for any special kind of commodity of which a great quantity is to be handled. Inclined chutes leading from a trap in the upper floor to the side of the pier may also be used for sending bagged flour direct to boat by gravity. The chute is hinged at the upper end, and its lower end has a telescopic portion which may be adjusted to deliver the bags where required. If bonded goods are to be handled, it will be necessary to divide off part of the house as a bonded warehouse.

"The double-deck pier has a number of advantages over a single-deck pier. The foundations are little, if any, more expensive, and it has approximately double the floor space, while, comparing floor space with roof, the cost is only one-half that of a single deck. The amount of real estate required is only about one-half. These advantages are great when the enormous value of terminal real estate is considered.

Very frequently the second story of these piers is so arranged that immigrants can be handled in it.

"It is frequently desirable to have an open track alongside export piers, as the character of goods to be handled is often such that they can be unloaded directly to or from the steamer and the car. This applies where the commodity is bulky and can be loaded in open cars, and in such cases it is frequently desirable to have this track. It saves the handling of the goods to the floor and from the floor to the car, or one handling. At certain European ports various types of traveling gantry cranes are used, which greatly facilitate the handling of freight.

"The storage pier has many features of the covered lighterage pier, but it is designed primarily to accommodate the large ocean-going steamers, while the other pier is built to store only goods for harbor lighters. The export pier is for the handling of general export business. It often happens, however, that the business of one road will be very largely made up of flour, paper, tobacco, or some other special commodity. In such cases the description above will hardly answer, and the design is made to meet the special requirements of the traffic. In the case of flour, which usually has to be held a long time, the pier should be several stories high, and the stories should be only about 10 ft. high in clearance. Cutting down the height of the stories saves in the cost of the building, and also in the labor of tiering up freight to a great height. In the flour storage warehouses all floors are reached by elevators, usually hydraulic or electric, and by endless-chain conveyors. Each warehouse should have platform elevators to facilitate the handling of trucks, etc., from floor to floor. With these arrangements, goods can be handled to and from any floor at very little cost.

"Where a pier is built in this manner, it is usually called a storage pier, but it should have all the other features of an export pier. Export piers should be so located that tracks will lead directly to and from the proper part of the general yard with the least amount of interference.

Freight Station Pier and Team Track Delivery

"In many harbors there are freight stations having no rail connections, and at which freight is received and delivered by car floats. The piers at these stations should be about 600 ft. long and 125 ft. wide. This width will allow for a 35-ft. driveway in the center, and 45 ft. storage space on each side. Where the tides will allow it, the driveway should be located at a level about 2½ ft. below the storage floor. In working out the height of the deck pier, the height of car floats, and fall and rise of the tide, and mean tide must be carefully considered. Ramps should be provided, as noted for open lighterage piers. The height of the abutting city street must not be overlooked, and the height that will require the least amount of work in handling freight under all conditions should be chosen. The pier should be surrounded on its three water sides with a 3-ft. platform, arranged with a proper number of cleats and mooring piles for tying up car floats. Along the water street should be built a bulkhead in connection with each pier 325 ft. long, to permit the tying up of two rows of car floats on each side of the pier.

"The pier will be used for inbound or city delivery freight, which in the morning will be moved from the cluster or general yard

on car floats and placed alongside the pier. The cars are at once unloaded. Outbound freight will be received alongside the bulkhead and moved by trucks over the ends of car floats and on the platform between the lines of cars on each float. In this way none of the outbound freight will pass through the pier proper, and all interference will be done away with. Inconveniences will only be had when the inbound freight is arriving so late in the day that the outbound must be loaded at the same time. During the morning hours it is customary to store the outbound freight on the floor of the bulkhead until some of the cars containing inbound freight have been unloaded. It is then moved directly from the wagon as it is received over the scales and into the proper car.

"In the design of these piers the same principles and requirements must be considered as in the case of covered lighterage piers. It is especially important to provide them with fire hydrants and possibly a chemical engine. Adequate roof lights should be arranged for, the lighting at night to be by electricity. It is usually not best to double-deck the pier, but the bulkhead should be two stories high, the second story to be occupied by offices for the agent and his staff, and for the storage of records. Where much fruit is handled, it will also be necessary to provide an auction room on this floor for the sale of fruit. It will often be found necessary to provide a water tank at the extreme end of the pier for supplying tugs with water. Alongside the roadway, leading into the pier at the front end of the bulkhead, should be provided a small office for use of the cashier in issuing freight bills. This will do away with the necessity of teamsters going to and from the office on the second floor to pay their freight and leaving their teams unprotected and blocking the driveway. It will be found to greatly expedite the movement. Scales for weighing freight should be provided at proper intervals along the bulkhead, with small houses in connection with each for the receiving clerks and the weighmasters. These piers are frequently divided up alphabetically, so that the goods for any person can be easily found. At some other points this classification is made by commodities, eggs being unloaded at one location and glass at another. Water-closets should be provided both on the office and on the lower floor. A lamp room is usually necessary, as it is difficult to reach the cars on car floats with electric lights, so that lanterns are generally used. This room should be as fireproof as it is possible to make it.

"Similar accommodations can be had by buying a block of property and building upon it the usual inbound and outbound freight stations, arranging the tracks from them to lead to a transfer bridge, so that cars can be moved between the freight houses and car floats. For operating the yard it will then be necessary to provide a small dummy engine, or handle the cars by electric power. The team tracks at such points are usually arranged in pairs, with the proper space for roadways. These tracks connect with ladder tracks leading to the transfer bridge. The arrangement will depend largely upon the shape and size of the property acquired."

A vast amount of freight is transferred between the rail and water lines in New York harbor; much of which is handled in cars on floats. The cars are run on or off the

floats over the float bridges. A float bridge must necessarily accommodate itself to the varying levels of the car float due to tide, which ranges from 4 ft. to 12 ft., and the difference in the depth of water drawn by the float itself when fully loaded and when light. One end of the transfer or float bridge is hinged to the bulkhead while the other is usually supported by pontoons which keep it afloat and raise or lower the bridge with the tide. The water end is hung by chains and, when required, the bridge is raised by means of these chains and windlasses. Jacks are used, too, to depress the float and at other times engines are run out on the bridge to depress it, an expensive and somewhat dangerous operation. Some floats have aprons at the ends which enable a closer and quicker adjustment to be made. These aprons are usually raised or lowered by some form of power device. An apron transfer bridge should preferably be electrically operated, and with such an arrangement a saving in the cost of operating may be effected. The superiority of this method over the pontoon bridge lies chiefly in eliminating the necessity for the use of an engine to aid in making the float fast, the bridgemen making all adjustments and connections. It is desirable, in order to avoid straining floats, that two engines be used and both sides loaded at the same time. With the heavier cars, of 80,000 and 100,000 lbs. capacity, this is essential. At best the method of using floats is cumbersome, but there seems to be nothing to take their place and handle freight as smoothly and rapidly.

CHAPTER XXI

Coal Piers

The annual output of coal in this country is approximately 275,000,000 tons, of which nearly 20 per cent. is anthracite. Pennsylvania produces the only anthracite, about 60,000,000 tons, and nearly 20,000,000 tons of bituminous coal. Illinois produces about 25,000,000 tons, and West Virginia nearly 20,000,000 tons.

The Norfolk & Western Railroad handles bituminous coal exclusively and has a heavy traffic. Lambert's Point, near Norfolk, Va., is its tide-water terminal, and the coal pier for handling coal from cars into boats is shown in Fig. 72.

This steel pier is 866 ft. long with unloading tracks throughout its entire length. It has an average height of 70 ft. above high water and accommodates ocean steamships. It has 54 chutes through which coal or coke can be loaded into the largest vessels. Loaded cars are hauled up the 25 per cent. incline leading to the entrance of the pier, by a stationary engine, working a cable, and from the top of this incline the cars are dropped by gravity, both going and returning.

The Curtis Bay coal dock of the Baltimore & Ohio near Baltimore, handles bituminous coal only. This dock is 800 ft. long from the shore line to the deep-water end where it is 45 ft. high — the width being 60 ft. The approach is 1,000 ft. long, giving a grade of about 2 per cent. to the incline. This approach track rises from a yard which has a capacity of 2,600 cars. At the top of the incline the cars are run over a 100-ton Fairbanks track scale. One of these scales is located in each of the two tracks and they weigh automatically. There are 100 unloading pockets of 180 to 350 tons capacity each. After the cars are dumped they are run by gravity to a switchback at the end of the dock where they are shunted to the return track and down the empty-car incline, 1,800 ft. long, to the yard and are again automatically weighed while in motion. The combined unloading capacity of the several old docks at

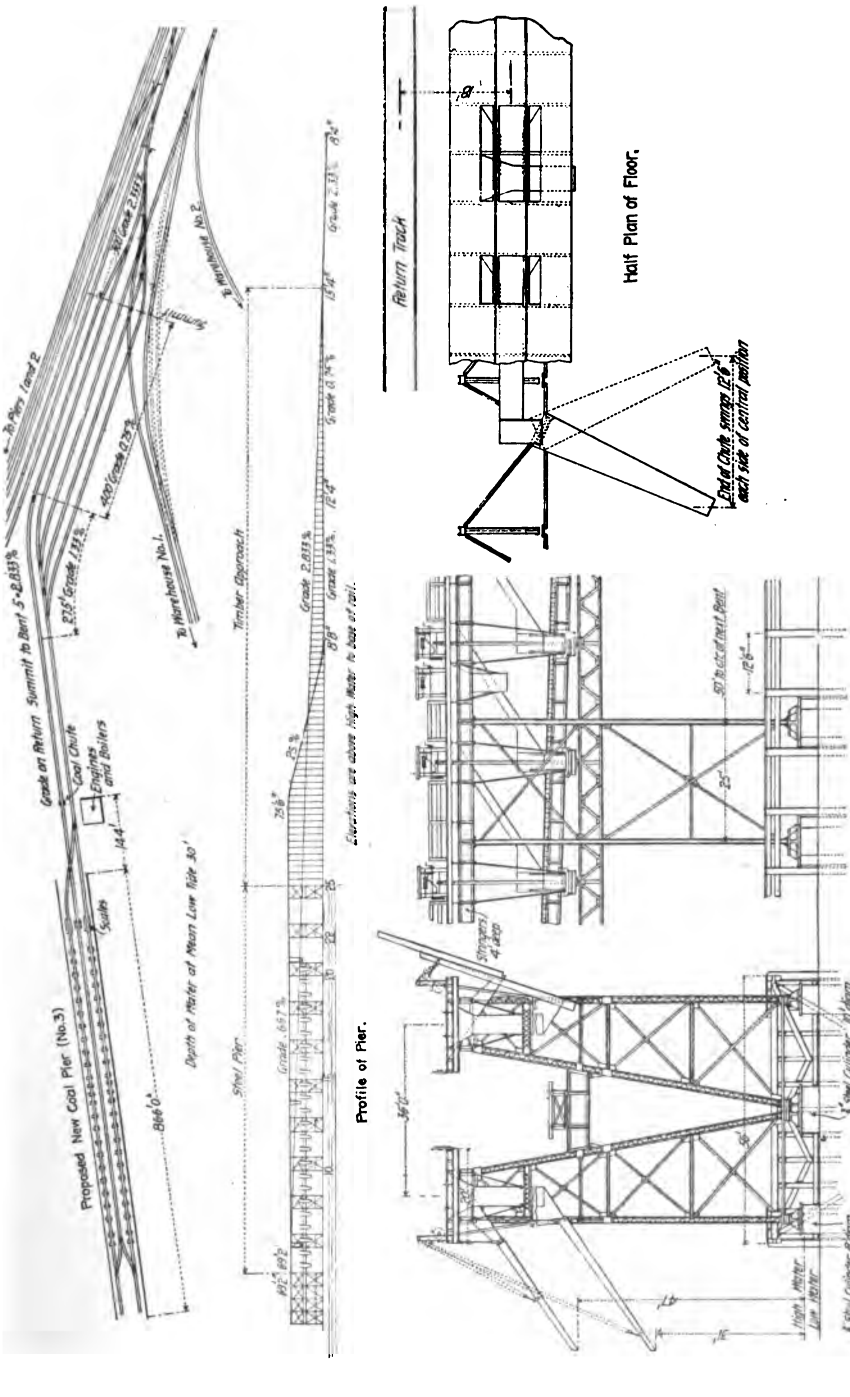


FIG. 72 — Norfolk & Western Coal Pier at Lambert's Point, Va.

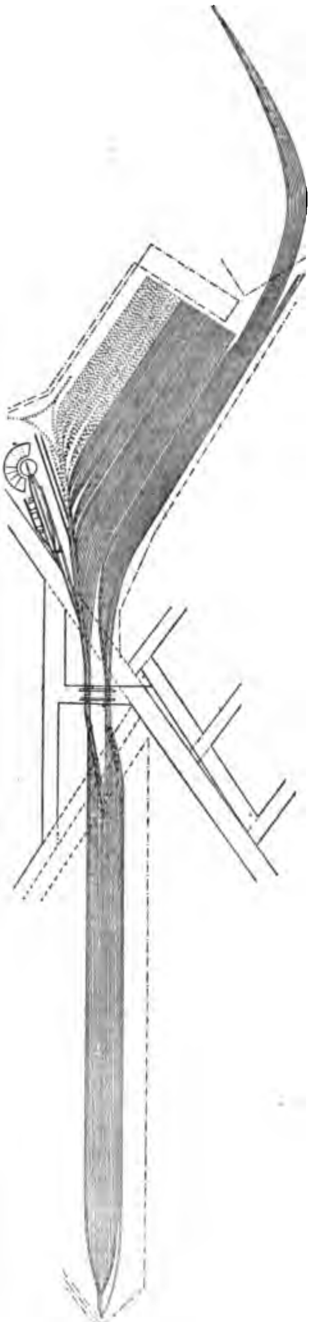


Fig. 73 — Plan of Baltimore & Ohio Coal Yard at Curtis Bay, Md.

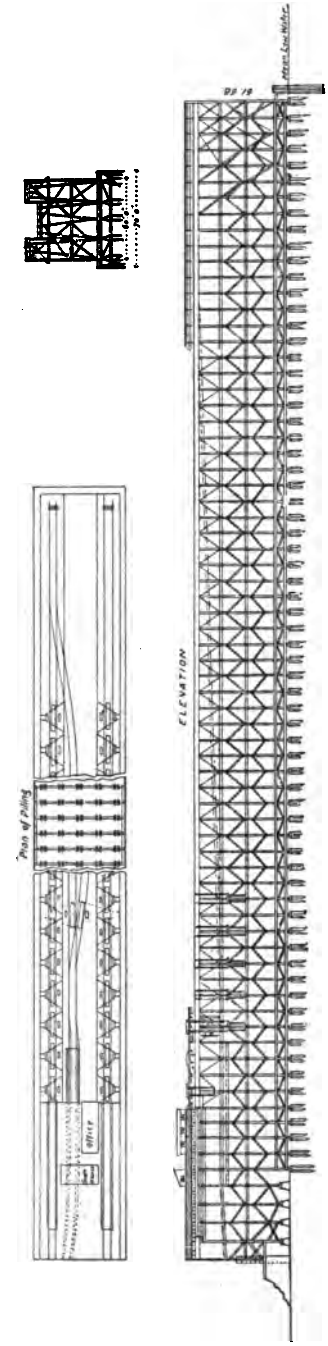


Fig. 74 — Plan and Elevation of B. & O. Coal Pier at Curtis Bay, Md.

Locust Point, Baltimore, was approximately 8,000 tons in 10 hours when cars of 25 to 30 tons capacity were used. With 50-ton cars the unloading capacity of the Curtis Bay dock is estimated at 10,000 tons, when vessels are at hand to receive cargoes.

At the new terminal at Port Covington of the Western Maryland, a large coal-handling pier 750 ft. long and 60 ft. wide has been built. This pier is equipped with 20 coal chutes on each side, in which the cars discharge the coal directly to the holds of the vessels lying alongside. The tracks on top of the pier are 70 ft. above mean low water. There are two outbound and two inbound tracks, the latter being in the middle. Loaded

FIG. 75 — Curtis Bay Coal Pier, Baltimore & Ohio.

cars are hauled up the incline on the inshore end by a " barney," power being supplied by a hoisting engine placed directly under the incline. It is estimated that the cars can be carried up this incline and unloaded at the average rate of one a minute. At the extreme end of the pier are two turntables which are used to transfer the cars as soon as they are emptied, from the outbound tracks to the inbound tracks, where they run by gravity down to the yard. Two track scales, one for loaded cars and the other for empty cars, are placed just beyond the " barney " pit, so that the cars can be weighed without delay. A concrete and masonary engine-house containing the hoisting engine has been built directly under the incline, as shown in

FIG. 76 — Coal Pier of the Western Maryland at Port Covington, Md.

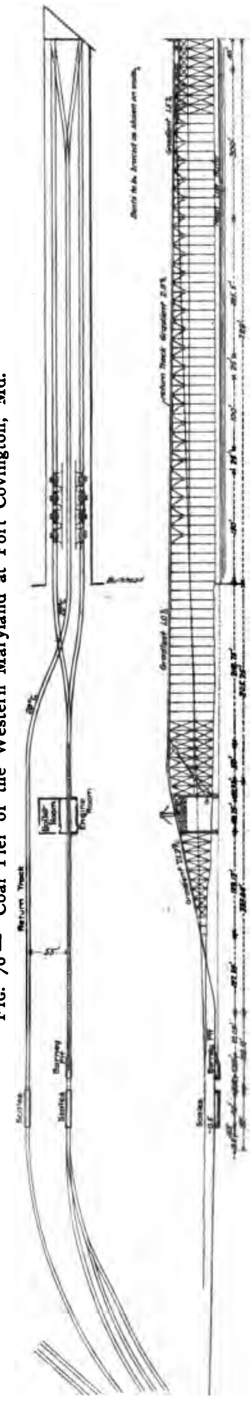
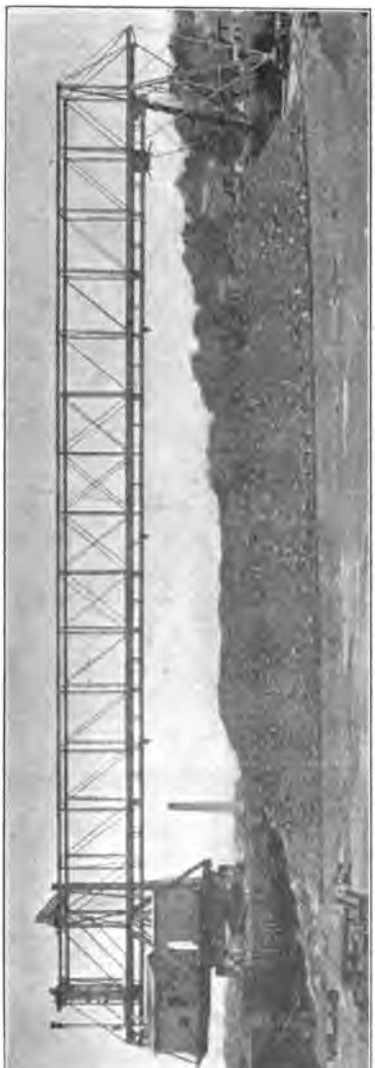
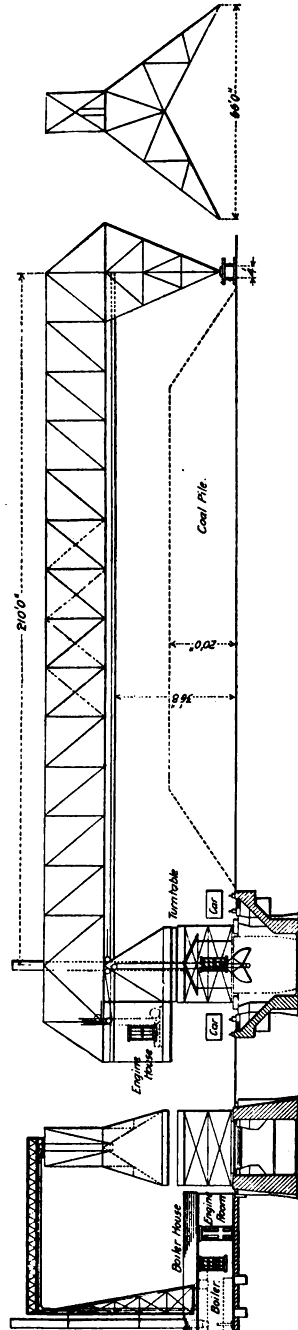


FIG. 77 — Plan and Elevation of Western Maryland Coal Pier.





FIGS. 78 & 79 — Coal Storage Plant of the New York Central at DeWitt, N. Y.

the accompanying drawing. This arrangement saves a large amount of space.

For storing coal, to hold for market requirements and to mechanically unload and reload it, the New York Central erected a plant at DeWitt which is shown in the accompanying illustrations.

This plant consists of a revolving steel truss 210 ft. long between supports. The inner end is carried on an elevated turntable and the outer end upon a steel frame, resting upon four-wheel steel trucks, traveling on a circular track 420 ft. in diameter, concentric with the elevated turntable. Under the turntable is a coal pit, on two sides of which coal can be

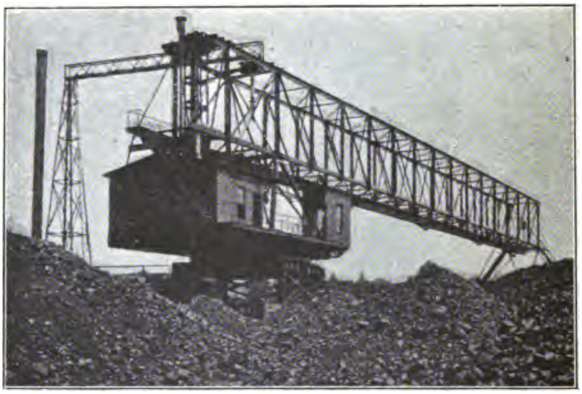


FIG. 80 — Coal Storage Plant at DeWitt, N. Y.

discharged from hopper-bottom cars. The coal is elevated from the pit by means of a 2½-ton clam-shell bucket, conveyed along the truss by wire rope trolley and deposited at any desired point in the storage area. The storage area has a capacity of 25,000 tons on each side of the coal delivery tracks. Coal may be delivered in and out of storage at the rate of 60 tons an hour, although on a test 120 tons an hour were handled. The average cost per ton handled is 3.5 cents, and under favorable conditions 2.7 cents.

The following table of the largest coal piers in this country is in convenient shape for those who may desire to give this subject more study:

Railroad and Location	Date when built	Size Feet	Method of Elevating Cars	% Grade on Approach	Grade of Delivery Tracks: No. of Tracks	Grade of Delivery Tracks: On Pier — Per Cent.	Grade of Return Tracks: On Pier — Per Cent.	Grade of Return Tracks: Beyond Pier — Per Cent.	Height: Shore End — Feet	Height: Sea End — Feet	No. of Tracks on Upper Deck	No. of Return Tracks
N. Y., O. & W., Cornwall, N.Y.	92	About 50×700	Inclined Plane Sea End.	......	1	....	....	....	....	....	4	2
P. R. R. No. 5, Greenwich Pt., Phila.	88	56×650	Loco. Incline Shore End.	About 2.	1	0.3	0.3	2.0	28.	30.	4	2
P. R. R. No. 6, Greenwich Pt., Phila.	02	735×50-60	Cable Incline Sea End.	17.5	3	1.0	2.8	1.5	65.	57.5	2	1
N. Y., S. & W., Cliffside, N. Y.	93	65×957	Inclined Plane	20.	2	{0.87 1.22	2.08	....	31.7	25.	4	1
P. & R., Port Richmond, Phila.	93	About 54×700	Loco. Incline	2.95	2	1.39	1.39	....		About 23.	....	....
P. & R., Port Richmond, Phila.	98	55×761	Loco. Incline	1.25	....	1.25			43.4		4	
P. & R., Port Reading, N. J.	91	56 wide	Loco. Incline	3.	2	1.33	3.0		36.	19.	4	2
N. & W. Lambert's Point, Va.	90	About 50×805	Loco. Incline	2.5	1	0.732	2.5	1.0	42.	35.	2	1
N. & W. Lambert's Point, Va.	02	56×850	Inclined Plane	25.	2	0.667	2.833	2.833	72.8	74.6	2	1
D. L. & W. Hoboken, N. J.	03	1283×60-72	Gravity	1.	....	Level	1.0	1.0	4.5	4.5		2
C. R. R. of N. J., Jersey City, N. J.	87	38 wide	Loco. Incline	2.64	2	{1.46 1.38	3.0		29.	20.6	2	1
D. & H. Weehawken, N. J.	87	....	Inclined Plane	17.5	1	1.04	1.74		35.		4	1
B. & O. St. George, S. I.	92	About 300 long	Loco. Incline	......	1	Level						
B. & O. Phila., Pa.	93	40×700	Loco. Incline	2.	2	Level			18.5	18.5	2	1
B. & O. Curtis Bay, Balt.	00	800×60	Loco. Incline	1.5	2	1.5	2.5	1.0	45.	45.	2	2
Erie, Weehawken, N. J.	91	....	Inclined Plane	20.	2	{0.87 1.22	1.4		36.	26.5	4	1
L.V.R.R. Pier A, Perth Amboy, N.J.	86	70×800	Gravity	0.6	4	0.6	1.0		29.5	25.	4	1
C. & O. Newport News, Va.	82	{44 wide 275 long	Loco. Incline	2.03	2	0.9	0.6			2 2.	2	1
D.L.&W. Pier No. 10, Hoboken, N.J.	84	64×995	Inclined Plane	16.	2	1.0	0.8		35.	25.	4	1

Tabulated Summary of Railroad Coal Piers.

The American Railway Engineering and Maintenance of Way Association recommends the general plan for a coal pier shown in Fig 81, and makes the following comments on the design:

"These coal piers are really open lighterage piers so arranged that coal from hopper-bottom cars can be readily discharged into vessels and barges. This arrangement makes it necessary to build the piers at a considerable height above the water. The height of the vessels to be loaded varies greatly. The coal is dumped directly from the car into a coal pocket, from which the coal is led through a chute to the vessel. The chutes are so arranged that they can be lowered, raised, or extended, and in this way can be made to reach the proper part of the vessel.

"Where hard coal is handled, it is necessary to equip the chutes with screens for eliminating the dust from the coal. A coal pier is usually made up of three tracks. The outside tracks are occupied by the loaded cars. As these are unloaded they are moved ahead and drop back to the middle track, which should be built on a grade falling toward the general yard, so that when the empty cars once get on to this track, they will feed naturally into the yard. The grade of the tracks on which the loads stand should be such that they will feed toward the outer end of the pier, to enable them to be easily shifted to the middle track. This arrangement of grades enables cars to be handled quickly, gives a greater capacity, and reduces the cost of handling. Coal piers which are exceptionally long should have five tracks, connected with suitable cross-overs, so that cars can be moved around those which are unloading at any particular berth.

"There should be a coal pocket provided for each car, and any number of them can be provided. They should be spaced the proper distance apart, and the more pockets there are on a side the greater will be the capacity of the pier and the less time will be lost in shifting. It is usually not good practice to have more than ten pockets on a side. The pockets should be located a little farther apart than the length of a car, so as to allow for unequal lengths. The grade leading from the general yard or cluster to the coal pier should be made as light as possible, as it is very difficult switching up the heavy grades which are usually necessary at such points. At a convenient point should be located a coal yard into which coal cars are switched in the order in which they should be run up on the trestle. At the end of the pier should be provided an office for the foreman, with a fireproof lamp-room. A storeroom should also be provided for tools. Coal piers should have a water space between them of about 150 feet. Where a large business is done, it will be necessary to provide at some point in the harbor close to the coal pier a stake boat to which all barges to be loaded are tied. A tug will move the vessels to and from this point to the coal pier. Platform room should be provided around the pier, so that the men can move from car to car, or to the shore, without walking on the tracks. It should be railed in so that there is no danger of the men falling off. Steps should be provided to enable men to get from the pier down to the boats at different points, as a certain force of men is constantly employed in the boats trimming cargoes, and these men have to move up and down. The pier should be

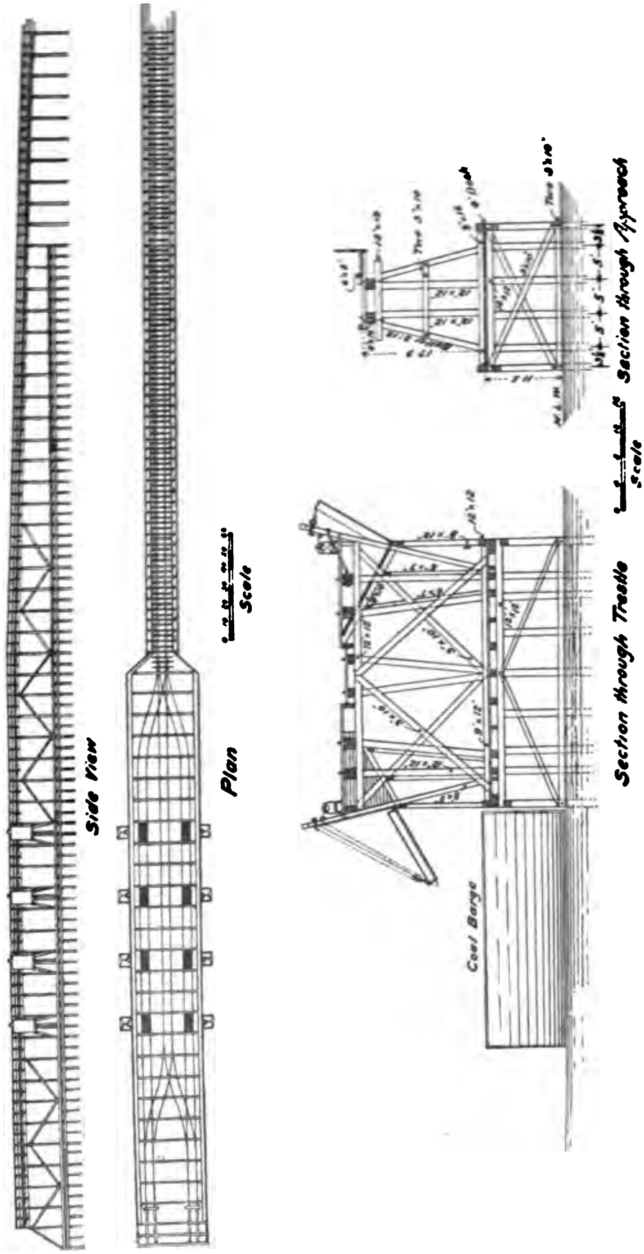


FIG. 81 — Design for Tide Water Coal Pier Recommended by the Am. Ry. Eng. & M. of W. Assoc.

provided with water-closets. Mooring piles should be provided at frequent intervals alongside of the pier for tying up coal barges.

" Some companies at the present time coal their tugs and other vessels at their regular coal piers. It is felt that this is not desirable, as it interferes very seriously with the handling of coal on the coal piers, unless it is done at night, and it would be advantageous to build a small pier for such use at a convenient location."

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